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EDITA IUSSU SOCIETATUM RADIOLOGICARUM
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VOL. 39 MAY 1953 FASC. 5

GASTRIC BLOCK

A Disturbance of Gastric Motive Function

by

Bengt Lilja

It has long been recognized that ulceration of the stomach may give rise to organic changes other than those produced by the ulcer crater as well as to functional disturbances. In ulceration of the incisura angularis, special changes have been observed (PRESSER, WARMOES) but not as yet subjected to systematic analysis. When the ulceration in this situation is of a gross nature, a characteristic impairment of the motive function is generally found. The sinus of the stomach forms an atonic pouch and its normal power of contraction appears to be lacking. Peristalsis is altered; the waves of contraction, after they have passed over the longitudinal part of the stomach, decrease in depth and in marked cases are replaced in the sinus region by superficial and frequent contractions of an irregular nature. A deep wave of peristalsis may, however, sometimes be noted.

The material of this investigation comprises 22 cases of ulceration of the incisura angularis, *i. e.* the total number of cases submitted to surgical treatment from 1946 to 1951 at the Central Hospital. The patho-histologic examinations in the 21 resected cases were performed by C. G. AHLSTRÖM at the Institute of Pathology at Lund.

In 18 of the cases in this series, dilatation of the sinus was observed. The ulceration was situated at, or immediately above, the incisura angularis. On roentgen examination the area of ulceration was found to measure at least one and frequently two or three cm. In the remaining 4 cases in which there was no dilatation of the sinus, the ulcer crater appeared to be somewhat smaller. The patho-histologic examination of the operation specimen showed destruction and fibrous transformation of the muscular wall. This also was found in the four cases showing no

Submitted for publication, April 1952.

From the Roentgen Department (Director: BENGT LILJA), Central Hospital, Halmstad, Sweden.

Fig. 1 Fig. 2

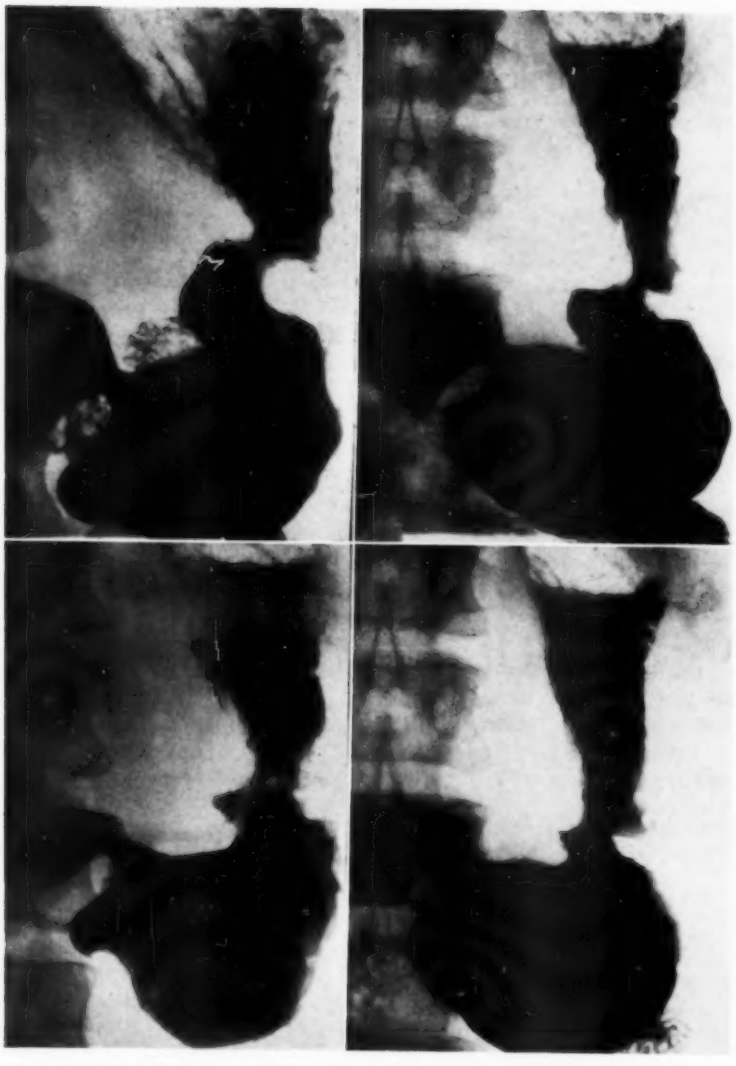

Fig. 3 Fig. 4

Figs. 1—4. Case 1. Ulcer of the incisura angularis at different examinations (June, July, October and November of the same year). The sinus is dilated and atonic, with impaired motivity; pylorus wide open. The muscular fibres radiate from the incisura angularis (Fig. 3).

dilatation of the sinus. In some cases, small parts of the muscular wall remained.

Four illustrative cases which were examined on different occasions are reported.

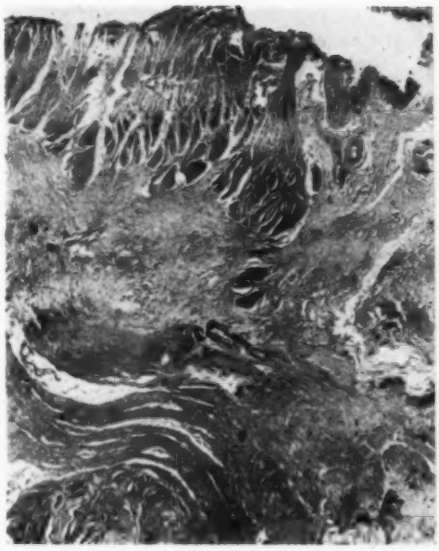

Fig. 5. Histologic examination of operation specimen from case 1. Muscular layer replaced by fibrous tissue.

Case 1 (Figs. 1—5). V. H., aged 47. The roentgenograms show the appearances of the stomach during the period the patient was under medical treatment. In spite of the ulcer diminishing during treatment, the stomach retained the same appearance: the sinus was dilated and showed impaired motive function. The pylorus was wide open. At operation, marked cicatrization was observed on the lesser curvature approximately at the incisura. It was situated somewhat towards the posterior wall of the stomach, which, in this region was adherent to the pancreas.

Patho-histologic examination (fig. 5): The ulcer was covered as is usual with non-specific granulation and necrotic tissue. Under this, the muscular layer was replaced by fibrous tissue. The adjacent mucosa of the canalis (the term canalis = canalis egestorius. See fig. 19) showed severe chronic inflammation with infiltration of plasma cells and hyperplasia of the lymph follicles. There was no suggestion of malignancy.

Case 2 (Figs. 6—10). R. N., aged 58, examined while under medical treatment. The films show the appearances of the sinus dilatation with the patient in different positions and with varying amounts of contrast medium in the stomach. Three years later a recurrence of the ulcer appeared. The line of demarcation between the canalis and the sinus was clearly evident in the form of a pronounced fold. At operation an ulcer crater, approximately 1 cm in diameter and surrounded by marked infiltration, was observed.

Patho-histologic examination (fig. 10) showed the ulcer to be covered by a fibrinous exudate and a necrotic layer, fibrous tissue replacing the muscular layer. There was abundant inflammatory cell infiltration but no evidence of malignancy.

Case 3 (Figs. 11—13). H. S., aged 40. The roentgen examination showed marked sinus dilatation and contraction of the canalis. At operation, an ulcer about 1 cm in diameter with extensive infiltration was found on the lesser curvature.

Patho-histologic examination (Fig. 13) revealed a large ulcer with considerably fibrosed walls. The fibrous tissue could be seen to radiate from the base of the ulcer through the

Fig. 6 Fig. 7

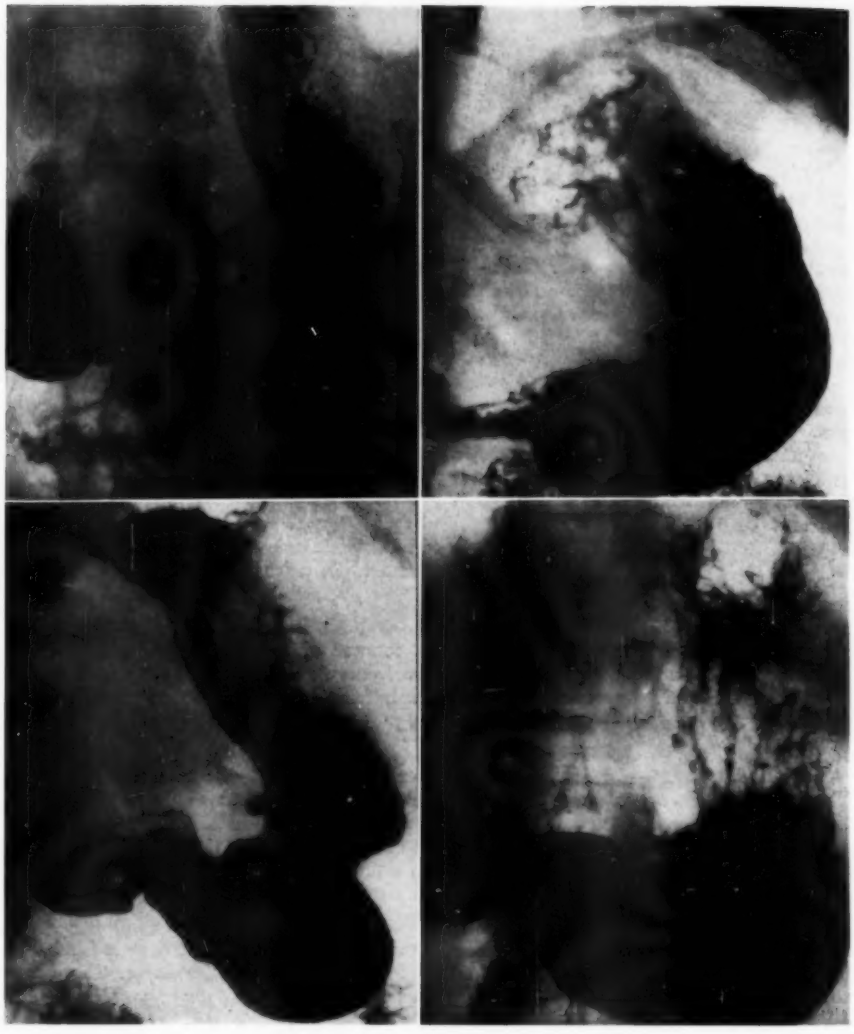

Fig. 8 Fig. 9

Figs. 6—9. Case 2. Ulcer above the incisura angularis at different stages of development, with typical sinus dilation. Fig. 9 shows the case three years after the first examination. Demarcation line between the sinus and the canalis appears as a fold.

Fig. 10. Histologic examination of operation specimen from case 2. Fibrous tissue replaces the muscular layer.

entire muscular layer and out into the surrounding subserous tissue. The mucous membrane in this area consisted of mucosa with very pronounced plasma cell infiltration. On the other hand, the glands were normal and there was no indication of malignancy. Some smaller arteries in the base of the ulcer showed evidence of endarteritis obliterans.

Case 4 (Figs. 14—18). H. S., aged 49. At the first examination (fig. 14), a large ulcer of the incisura angularis together with a dilated and atonic sinus were found. The niche had almost entirely disappeared at the next examination carried out a month later but the sinus change persisted (fig. 15). A year later, the ulcer recurred (fig. 16). The sinus was still dilated and atonic but an occasional deep peristaltic wave was seen to pass along its walls (fig. 17). Operation revealed infiltration the size of a finger-tip with a pea-sized ulcer, on the lesser curvature.

Patho-histologic examination (fig. 18) disclosed a fibrosed ulcer with a necrotic superficial layer in the region of the incisura on the lesser curvature of the stomach, the walls consisting of fibrous connective tissue interspersed with round cell infiltration and enveloping thick-walled vessels. The mucous membrane surrounding the ulcer appeared to be somewhat atypical but presented no suggestion of malignancy. Considerable gastritis of the follicular and interstitial type was observed in the region of the antrum.

It will be noted that in the four cases reported, all the patients had large ulcers situated in the region of the incisura with advanced destruction of the muscular layer. The ulcers gave rise to pouch-shaped dilatations of the sinus with atonicity and impaired motive function. This impairment was most evident under fluoroscopy, but could also be seen in roentgenograms taken at varying time intervals. In the pouch-shaped sinus, peristalsis was generally atypical and consisted of irregular small contractions. Deeper peristaltic waves appeared only occasionally.

Fig. 11

Fig. 12

Figs. 11—12. Case 3. Ulcer above the incisura angularis with marked dilatation of the sinus. Contracted distal part of the canalis. (Ulcer crater visible in Fig. 11 only.)

Fig. 13. Histologic examination of operation specimen from case 3. Large ulcer crater with considerably fibrosed walls; fibrous tissue radiates from the surface of the ulcer through the muscular layer.

Precise demarcation of the sinus is difficult in an ordinary roentgen examination. The earlier physiologists spoke of a transverse band at the level of the incisura angularis which divided the stomach into two communicating parts. A similar ring-like constriction of the lumen in the region of the incisura has been observed many times by various investigators on post-mortem examination carried out immediately after death following judicial execution.

The same observation has also been made in gastroscopic examinations. Nothing resembling this transverse band, however, seems to have

Fig. 14

Fig. 16

Fig. 15

Fig. 17

Figs. 14—17. Case 4. Ulcer of the incisura angularis. The dilatation of the sinus remains after healing of the ulcer (Fig. 15). It is evident from Fig. 17 that a deep peristaltic wave may pass over the sinus occasionally.

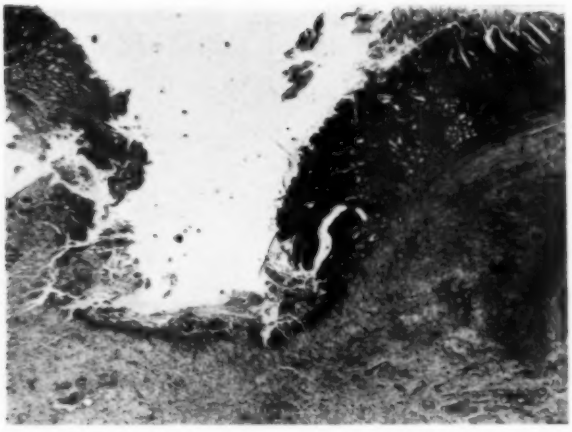

Fig. 18. Histologic examination of operation specimen from case 4. The walls of the ulcer consisted of fibrous connective tissue; considerable destruction of the muscular layer.

been observed roentgenologically. An existing fold might possibly disappear when the stomach is filled with contrast medium.

It is usually difficult to determine exactly the line of demarcation between the corpus and the sinus even in cases with pouching of the sinus in association with ulceration at the incisura angularis. The lower limit of the sinus, however, is frequently seen very clearly in the form of a distinct fold (figs. 6—9); no permanent fold exists at this point. The folding seems to have arisen through a change in the muscular structure at the line of transition between the radial musculature in the sinus and the circular musculature in the canalis. In the earlier anatomic literature a fold at the same site is mentioned and called the 'sulcus intermedius'.

In certain cases, muscular fibres radiating from the incisura may be seen extending over the entire sinus. It seems probable that this folding depends upon the underlying radial musculature.

The appearance of the canalis also frequently deviates from the normal. An irregular and oblique folding of the mucosa associated with irregular contractions at infrequent intervals may be observed. In several cases, the canalis shows a funnel-shaped contraction (figs. 11—12) although in others the canalis, throughout the examination, has a normal appearance but the pylorus is wide open (figs. 1—4). These observations suggest that a disturbance in the canalis may occur in cases of ulceration of the incisura angularis. Similar changes in the canalis have been observed previously, though their cause has not been understood. Further investigations appear desirable.

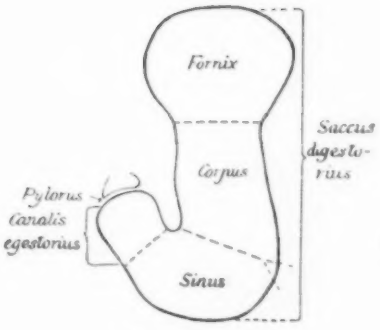

Fig. 19

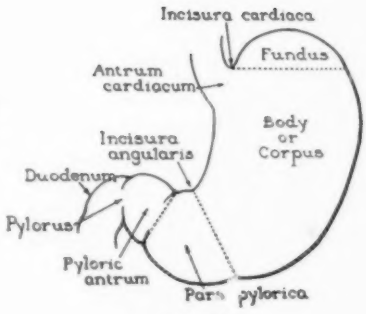

Fig. 20

Fig. 19. Nomenclature according to FORSSELL (drawing from Forssell's book).
Fig. 20. Nomenclature according to ALVAREZ (drawing after LEWIS, from Alvarez' book).

In order to illustrate the effect of ulceration of the incisura upon the sinus as shown in an unselected material, all cases with ulcers submitted to roentgen examination of the stomach during the years 1950 and 1951 have been registered. Of these 757 cases, ulceration at the incisura angularis was found in 44, of which 27 had a pouch-like dilatation of the sinus, 15 had no such dilatation and 2 were questionable. Of the 33 cases with large ulcers (at least 1 cm in diameter in the roentgenogram), 25 had a dilated sinus and in 2 cases the dilatation was questionable. Of the 11 patients with small ulcers, only 2 showed dilatation.

The 22 operated cases with large ulcers all showed evidence of destruction of the musculature in this region and 18 of these had dilatation of the sinus. In 25 out of 33 cases in the material not subjected to operation and presenting signs of large ulcers at the incisura, there was a similar dilatation. A reversion of the condition of the sinus from one of dilatation to normal form exhibiting ordinary peristalsis, following healing of the ulcer, has never been observed in this material. This suggests that a destruction of the wall of the stomach must have been the underlying cause for the disturbance in function.

In order to gain a conception of the significance of these observations, certain essential features of the anatomy of the stomach must firstly be considered.

In describing the various parts of the stomach, the writer has followed the nomenclature proposed by FORSSELL (1910), according to which the longitudinal stomach is divided into the fornix and the corpus, and the transverse stomach into the sinus and the canalis. This nomen-

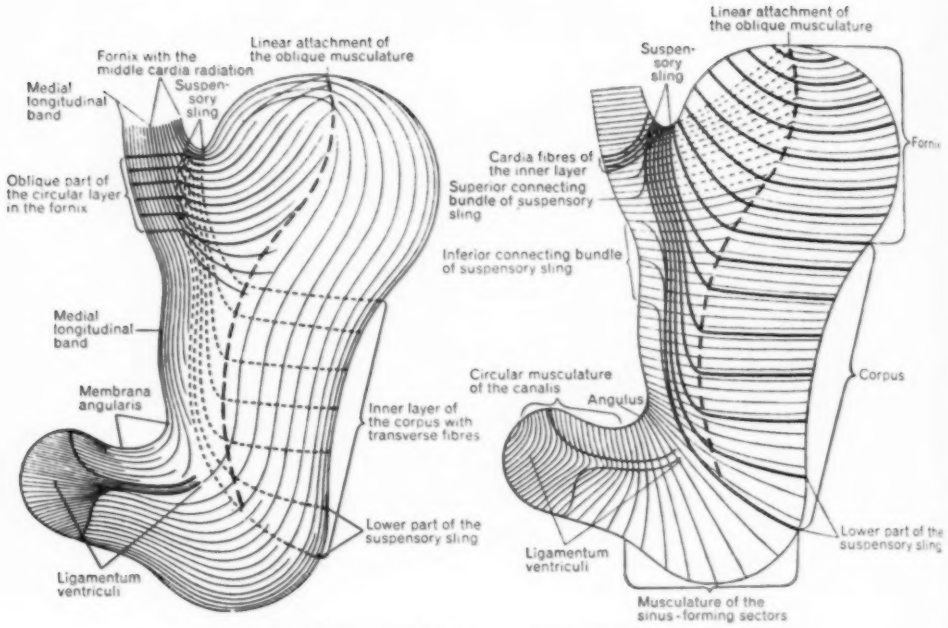
Linear attachment of the oblique musculature
Fornix with the middle cardia radiation
Suspen-sory sling
Medial longitudinal band
Oblique part of the circular layer in the fornix
Medial longitudinal band
Membrana angularis
Inner layer of the corpus with transverse fibres
Lower part of the suspensory sling
Ligamentum ventriculi
Linear attachment of the oblique musculature
Suspen-sory sling
Fornix
Cardia fibres of the inner layer
Superior connecting bundle of suspensory sling
Inferior connecting bundle of suspensory sling
Circular musculature of the canalis
Angulus
Corpus
Lower part of the suspensory sling
Ligamentum ventriculi
Musculature of the sinus-forming sectors

Fig. 21. The muscular layers of the stomach (FORSSELL).

clature does not entirely correspond to that used by ALVAREZ in his handbook of the physiology of the digestive tract (1948). This latter author divides the longitudinal stomach into the fundus and the corpus, and the transverse stomach into the pars pylorica and the pyloric antrum. Thus, the sinus of FORSSELL is the same as the pars pylorica of ALVAREZ. The two schematic drawings illustrate the nomenclature used by these writers. (Figs. 19—20.)

The following review of the muscular wall is based upon FORSSELL's description. The muscular wall consists of three layers (fig. 21). The outer longitudinal layer, which for the most part is thin, is reinforced in the vicinity of the cardiac orifice by a larger bunch of fibres and descends as a well-marked band along the lesser curvature (the medial longitudinal muscle band); at the incisura angularis, having somewhat divided, the band continues to the superior portion of the sinus and extends to the so-called ligamenta ventriculi; these, in the transverse stomach, consist of strands of longitudinal musculature situated anteriorly and posteriorly.

The middle muscular layer (the circular) covers the whole of the

stomach. The distribution of the musculature in the sinus is of particular interest. The circular layer is locally thickened in the area of the incisura angularis from which the muscular fibres radiate fan-wise over the sinus.

The inner muscular layer consists of a superior portion situated close to the oesophageal opening radiating into the fornix as well as a strong bunch of muscular fibres, the suspensory sling, which spreads down along the corpus of the stomach on the anterior and posterior surfaces. These fibres then run in a lateral direction and blend with the circular layer and the submucosa. This suspensory sling extends downwards to the level of the incisura angularis, but does not continue over to the sinus.

The medial longitudinal band of the outer longitudinal layer, as well as the suspensory sling of the inner oblique layer, are attached superiorly at the cardia and are no doubt important in suspending and supporting of the stomach. Both these muscular bands terminate at the level of the incisura angularis, but the medial longitudinal band extends slightly into the superior part of the sinus which it possibly stabilizes. The suspensory sling probably does not afford a similar support to the sinus as its termination just marks the superior line of demarcation of the sinus.

It thus seems evident that the incisura angularis, from a purely anatomic point of view, is an important area of the stomach. It is the focal point for the circular muscular fibres radiating to the sinus. Sufficiently severe injury in the form of ulceration at the incisura angularis would seem capable of extending any impairment of motive function to the entire sinus.

Embryologically the stomach may be said to form an asymmetric dilation to the left of the primitive digestive tube. The site of the incisura angularis should not be overlooked. The part of the stomach proximal to the incisura angularis, the longitudinal part — with the fundus glands — is developed from the oesophagus, which thus, ontogenetically, extends to the incisura angularis. The inferior portion of the stomach, the transverse part — with the pyloric glands — is formed from the part of the primitive digestive tube below the incisura angularis.

The following brief review of the gastric motive function essentially follows the description by ALVAREZ.

Although the physiologists, as ALVAREZ says, are still uncertain as to the exact manner in which the peristaltic waves travel to the pylorus, certain aspects of the complex motive function of the stomach are nevertheless important in the understanding of the present observations.

Physiologic experiments have shown that various portions of the muscular wall of the stomach have different characteristics. The tendency to rhythmic contractions is greatest on the lesser curvature near the cardia. There are marked variations in tonus in different parts of the stomach. The tonus is considerably stronger on the lesser than on the

greater curvature. Electric irritability is greatest close to the cardia, where the latent period is shortest. The musculature in the fornix has a tendency to tonic contraction, while the musculature of the transverse stomach relaxes immediately.

Variations in the character of the muscles in the segments of the stomach make differentiation of motive activity possible. The peristaltic waves have been studied the most. The mechanism of these contraction-waves seems to be situated in the gastric wall itself, and their transmission is influenced by the condition of the wall in its different parts. The significance of the nerve elements embedded in the gastric wall does not seem to have been determined as yet. In experiments in animals, the waves travel across the stomach even if the vagus and sympathetic nerves are severed. Thus these two nerves appear to have only indirect significance, accelerative or inhibitory, in the motive function of the stomach.

It is generally believed that peristaltic waves may originate from any point in the stomach. Usually, however, they arise in the region of the cardia. It has been found possible, by physiologic methods, to record them in that region, but in the upper part of the stomach they are so shallow that they cannot always be demonstrated by roentgen examination. The physiologic irritability of the stomach is greatest, and the latent period is shortest, near the cardia. Accordingly, for the most part, the contraction impulses originate near the cardia, and the presence of a pace-maker in this area has even been suggested. The irritability decreases and the latent period becomes somewhat longer in an inferior direction along the lesser curvature, and particularly in a direction across from the lesser to the greater curvature.

ALVAREZ points out that the gastric waves sometimes seem to hesitate or lose time as they cross from the body of the stomach to the pars pylorica. Photographic records suggest that this is due to a difference in the rate of conduction of the waves in the two parts of the stomach.

In electrogastrograms in dogs and cats, for example, it may be observed that the waves are more frequent in the longitudinal part of the stomach than in the transverse part, changing in frequency from 10 per minute in the longitudinal stomach to about 3 per minute in dogs and 4—6 per minute in cats in the transverse stomach. ALVAREZ demonstrated a not infrequent dissociation of the activity in the two parts of the stomach, and an occasional complete independence of the rhythmic activities in the two regions, with the corpus of the stomach contracting about three times to the one contraction of the pars pylorica. It might be mentioned here that the anatomic structure of the stomach in the cat is very similar to the structure of the stomach in man. In electrogastrograms in the latter, ALVAREZ has also observed peristaltic

waves in the longitudinal stomach ith a frequency of 11 per minute, while the frequency in the transverse stomach was only 3 per minute. Thus it seems that the region of the incisura angularis has a particular physiologic significance in the motive function of the stomach.

ALVAREZ writes: "We see then that local peculiarities in the muscle, with graded differences in rhythmicity, irritability, tonus and latent period probably have most to do with directing the peristaltic wave as it travels over the stomach. As in the heart, so here, the waves probably have their origin in regions in which the muscle is most rhythmic and sensitive. It may be that, ordinarily, the highly rhythmic region on the lesser curvature next to the cardia serves as a sort of pace-maker for the body of the stomach, while a similar region near the incisura starts waves over the pars pylorica."

The physiologic observations thus point to two regions of especial importance in the motive function of the stomach; one near the cardia, the other in, or near, the incisura angularis. Both these regions might thus be called motive centres. It has been demonstrated that at the level of the incisura angularis a dissociation of the activities of the longitudinal stomach and transverse stomach may take place.

Even the anatomic distribution of the musculature in the region of the incisura angularis appears to tend to spread the impulses originating there. The muscular fibres radiate from the incisura in the form of a fan over the sinus.

It seems logical to assume that the observations made by the writer on roentgen examinations of the stomach in cases of ulceration of the incisura angularis might be explained by these anatomic and physiologic conditions. The ulcer crater at the incisura may be equivalent to an injury caused experimentally. The sequelae of both lesions may be the same. In cases of large and deep ulcers in this region a pouch-like, atonic dilatation of the sinus occurs, associated with irregular peristalsis, generally with superficial and irregular, but sometimes, isolated deeper waves. Through the destruction of the muscular wall caused by the ulcer, the centre of motive function, situated at the incisura angularis, disappears. On the other hand, there was no such impairment of motive function in four cases with destruction of the wall. Whether this depended on the wall not being sufficiently deeply involved or, in these cases, the centre of motive function not situated at the incisura, is not conclusive from this material. Whether or not the dilatation of the sinus depends partially upon injury to the medial longitudinal band, with impaired vertical stability of the stomach, cannot be settled. It seems as if the term 'block' could be borrowed from cardiac pathology for the impairment of motive function originating at the incisura angularis, despite the great dissimilarity between the motive activity in the heart and that in the

stomach. ALVAREZ anticipates the possibility of being able to diagnose impairment of motivity in the stomach and also uses the denomination 'block'; such a condition, however, has previously not been demonstrated roentgenologically.

The roentgenologic demonstration of a gastric block in cases of ulcer of the incisura angularis is of more than theoretic interest. If the alteration in the motivity is clear, it indicates that the ulcer has caused considerable organic change in the wall. If the ulcer heals, a persisting alteration in the motivity signifies that restitution ad integrum has not occurred. On the other hand, if an ulcer in the incisura angularis is demonstrated without signs of a block, it indicates that the ulcer is more superficial. The presence or absence of gastric block in ulceration of the incisura angularis may therefore be important in the determination of the necessity for operation.

SUMMARY

In cases of gross ulceration, with destruction of the muscular layer, of the incisura angularis, characteristic impairment of motive function in the stomach occurs. This impairment of motive function is correlated with the dissociation, demonstrated by physiologists, between the peristaltic waves on the two sides of the incisura angularis. The anatomic structure of the stomach, *i. e.* the radiating muscle layer of the sinus centered in the incisura angularis, favours the spreading of an impairment of the motive function from this focal point to the sinus as a whole.

The term 'gastric block' is suggested for the impairment in the gastric motive function in cases of ulceration of the incisura angularis.

ZUSAMMENFASSUNG

In Fällen von Ulzeration der Incisura angularis mit Zerstörung der Muskelschicht entsteht eine charakteristische Störung der Bewegungsfähigkeit des Magens. Diese Störung wird mit der von den Physiologen schon angezeigten Dissoziation der peristaltischen Wellen zu beiden Seiten der Incisura angularis zusammengestellt. Die anatomische Struktur des Magens, d. h. der radiierende Verlauf der Muskelschicht des Sinus von der Incisura angularis ausgehend, begünstigt die Ausbreitung einer Funktionsstörung von diesem Focus zu dem gesamten Sinus.

Für die Veränderung der Ventrikelmotilität in Fällen mit Ulkus der Incisura angularis wird der Ausdruck »Magenblockierung« vorgeschlagen.

RÉSUMÉ

Il se produit, dans des cas d'ulcère grave de l'incisure angulaire détruisant la couche musculeuse ici, un trouble caractéristique de motilité. Cette perturbation de la motilité est comparée avec la dissociation, démontrée par les physiologistes, des ondes péristaltiques de part et d'autre de l'incisure angulaire. La structure anatomique de l'estomac, en raison de la disposition radiée de la couche musculeuse de cette partie centrée sur l'incisure angu-

laire, favorise l'extension d'une perturbation de la motilité à partir de ce point au sinus entier.

L'auteur propose le terme de «bloc gastrique», pour la perturbation de la motilité gastrique qui se produit dans des cas d'ulcération de l'incisure angulaire.

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FROM THE ROENTGEN DIAGNOSTIC DEPARTMENT (DIRECTOR: PROFESSOR KNUT LINDBLOM), KAROLINSKA SJUKHUSET, STOCKHOLM, SWEDEN

CATHETER REPLACEMENT OF THE NEEDLE IN PERCUTANEOUS ARTERIOGRAPHY

A new technique

by

Sven Ivar Seldinger

The catheter method of angiography has become more popular in the past few years, as it provides the following advantages over the method of injecting the contrast medium by means of a simple needle:

1) The contrast medium may be injected into a vessel at any level desired.

2) Risk of extravascular injection of the contrast medium is minimised.

3) The patient may be placed in any position required.

4) The catheter may be left in situ without risk while the films are being developed, thus facilitating re-examination if necessary.

Until recently, however, the use of the catheter method was restricted because of the lack of a suitable flexible thin-walled catheter which could be used percutaneously. FARIÑAS, in 1941, described a method in which a urethral catheter was passed up into the aorta through a trocar inserted in the exposed femoral artery. In 1947, RADNER catheterized the exposed and ligated radial artery and performed vertebral angiography and later thoracic aortography. Since then, many authors have catheterized arteries for various purposes, by surgical exposure followed by ligature or resuturing of the artery. In 1949, JÖNSSON performed thoracic aortography after puncture of the common carotid artery by means of a blunt cannula provided with an inner sharp needle. The cannula, guided by a silver thread, was then directed downwards. Later

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the procedure was abandoned, partly because it was considered that the cannula might injure the aortic wall. This percutaneous method might have proved more useful if a technique for using a flexible catheter of adequate lumen had been available at the time.

The artery exposure technique of catheterization is time-consuming, troublesome and may present certain risks. The thin-walled polyethylene tube, however, makes percutaneous catheterization possible, as reported by PEIRCE in 1951, who passed in the tubing through a large bore needle. This method was suitable for aortography via the femoral artery. In the same year, DONALD, KESMODEL, ROLLINS and PADDISON, employing a similar technique, catheterized the common carotid artery in cerebral angiography. The method necessitates the use of a large bore needle which may make puncture difficult and limits its use to comparatively large arteries, hence PEIRCE's attempts to catheterize the brachial artery were disappointing. There is also extra damage to the artery and, as the hole in the artery is larger than the catheter, haemorrhage after removal of the needle may be troublesome. To prevent bleeding, the needle may be kept in situ during the investigation; this, however, increases the risk of injury to the patient during movement.

Fig. 1. The equipment. The stilette is removed and the leader inserted through the needle (left) and the catheter (right).

There is a simple method, however, of using a catheter the same size as the needle, and which has been used at Karolinska Sjukhuset since April 1952. The main principle consists in the catheter being introduced on a flexible leader through the puncture hole after withdrawal of the puncture needle. The details are as follows:

Equipment. (Supplied by A. B. Stille-Werner, Stockholm.)

1) A puncture needle with stilette.

2) A flexible rounded-end metal leader with increased flexibility of its distal 3 cm.

3) A polyethylene tube, of the same diameter as the needle, with an adapter for the attachment of a syringe.

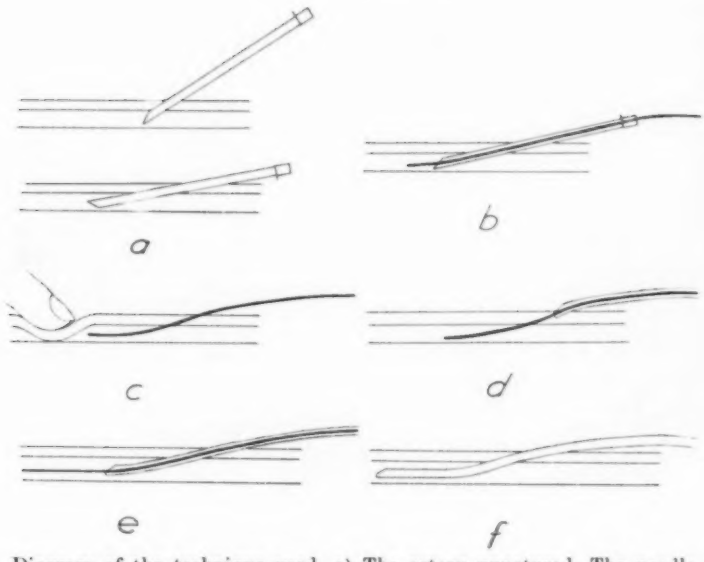


Fig. 2. Diagram of the technique used. a) The artery punctured. The needle pushed upwards. b) The leader inserted. c) The needle withdrawn and the artery compressed, d) The catheter threaded on to the leader. e) The catheter inserted into the artery. f) The leader withdrawn.

The leader should have a diameter slightly less than the bore of the needle and the catheter, so that it is capable of passing through both, and should be at least 8—9 cm longer than the latter; on the other hand it should just fit the lumen of the catheter (Fig. 1). The tip of the catheter may be cut before use as shown in Fig. 2.

Technique (see Fig. 2).

a) After local anaesthesia, the artery is punctured percutaneously at a relatively small angle.

After puncture it is best to rotate the needle 180° and push it a little into the artery using the bleeding as a guide to ensure that the needle remains in the artery. Puncture of arteries smaller than the femoral artery is facilitated by using an inner needle as a guide over which the outer needle is directed into the artery.

b) The supple tip of the leader is inserted a very short distance into the lumen of the artery through the needle.

c) The leader is held in place and the needle removed.

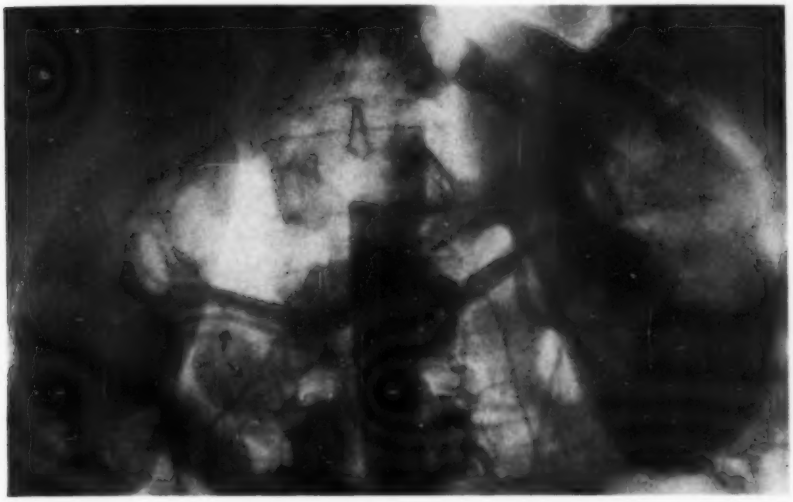


Fig. 3. Hypoplastic lower pole of the right kidney. Blood supply from two branches of a small aberrant artery. Catheter inserted through the right femoral artery with tip 2 cm below the renal arteries.

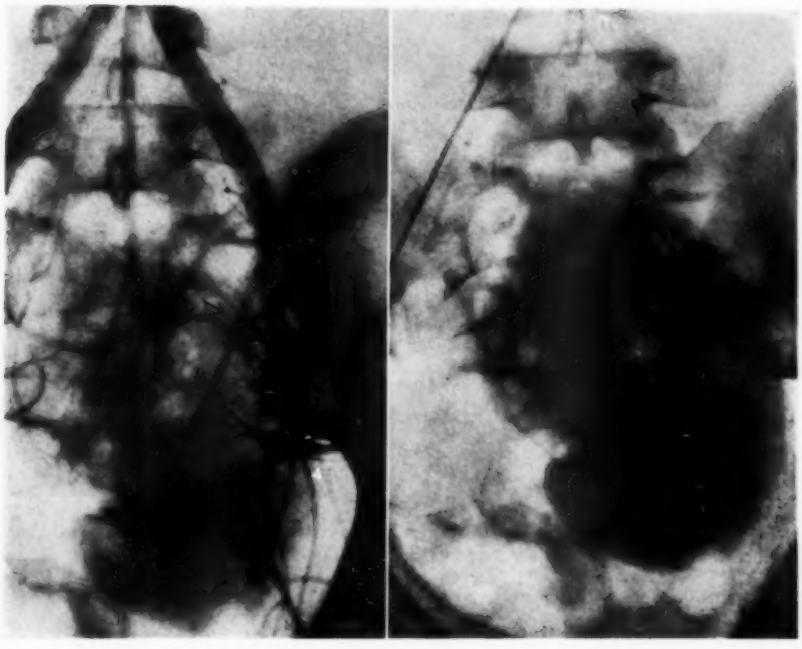
At this moment bleeding should be controlled by pressure on the artery proximal to the puncture site, because the diameter of the leader is smaller than the hole in the artery.

d) The catheter is threaded on to the leader; when the tip reaches the skin the free end of the leader must protrude from the catheter.

e) The catheter and leader are gripped near the skin through which they are inserted. The catheter enters the artery easily as an opening has already been made by the needle. The catheter and leader are pushed just far enough to ensure that the tip of the former is in the lumen of the vessel.

f) The leader is removed and the catheter directed to the level required, after good arterial bleeding through the catheter has been obtained. The unsupported catheter is usually pushed up the vessel without difficulty, but occasionally the leader must be re-introduced into the catheter in order to support it. The leader should not be passed beyond the tip of the catheter.

This technique is simpler than appears on paper and after a little practice should present no difficulties. It is important that the leader passes into the artery easily. When the tip of the catheter enters the artery, the same resistance is often felt as when puncturing is performed



a. b.

Fig. 4. Left-sided ectopic kidney in pelvis. (Right kidney absent.) Blood supply by one artery from the iliac bifurcation and one from the left internal iliac artery. Catheter inserted through the right femoral artery with tip at the bifurcation. a. Arterial phase. b. Capillary phase.

by means of a needle. However, the resistance is generally but slight or may be completely absent. If considerable resistance be encountered, it is probable that the tip of the leader is obstructed and force must therefore never be applied.

Polyethylene tubing is unfortunately not radio-opaque. For this reason, in aortography via the femoral artery, a small amount of contrast medium may be injected and followed by a test exposure. This will show the position of the catheter and also the exact situation of the renal arteries and of the iliac bifurcation. When the brachial artery is catheterized, the procedure is carried out in the fluoroscopy room and the leader used as an indicator of position; the catheter is then kept free from blood by the injection of saline solution.

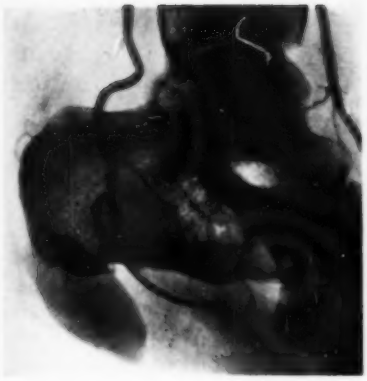


Fig. 5. Cavernous angiomas of the heel. Arterial phase. Catheter inserted through the femoral artery with tip in the popliteal artery. The difficult puncture of the popliteal artery was replaced by the easily performed catheterization from the inguinal region.

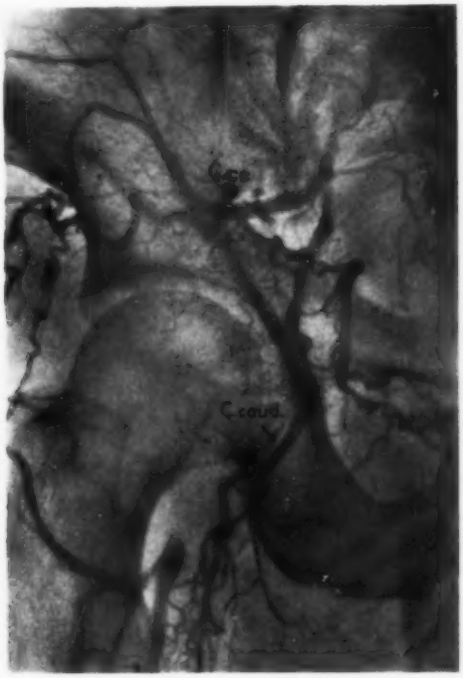


Fig. 6. Occlusion of the right external iliac artery. Collaterals from the superior gluteal to the deep femoral artery. Inner part of the thigh supplied from the inferior gluteal artery. Catheter inserted through the left femoral artery with tip at the bifurcation. G. cr. = superior gluteal artery. G. caud. = inferior gluteal artery. P. f. = deep femoral artery.

Summary of Investigations Performed

40 arterial catheterizations have been carried out; of these, 35 were aortographies via the femoral artery, 3 subclavian arteriographies by means of puncture of the brachial artery in the antecubital fossa, and 2 catheterizations of the femoral artery in a distal direction. In no case was general anaesthesia employed. Injection was made throughout by hand. The contrast medium used was 30 cc of Umbradil in each injection with a concentration of 35 % in peripheral arteriographies and 70 % in aortographies except in those cases in which compression of the femoral arteries was used, when a 50 % solution was employed. The tubing used was in all cases No. 200 (internal diameter 1.40 mm, external diameter 1.90 mm) or No. 205 (1.57 mm and 2.08 mm). The latter seemed to be the optimal one for aortography. As the thickness of the wall of the needles available is nearly

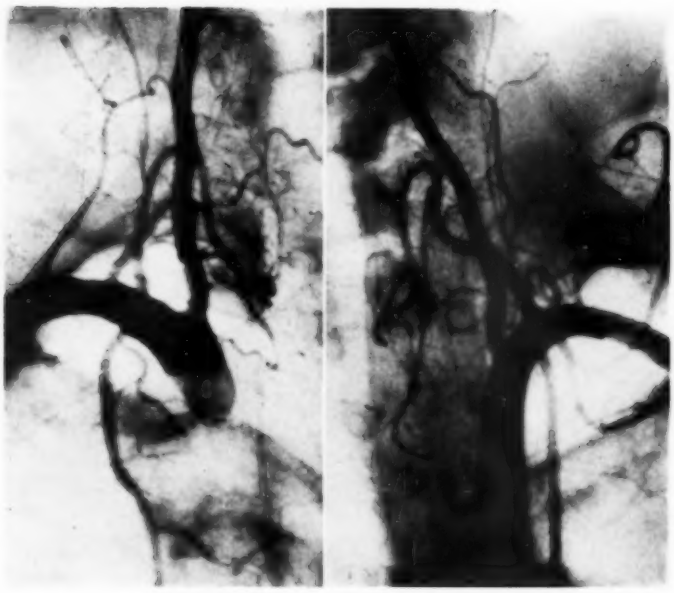


Fig. 7. Catheter inserted through the antecubital artery of both sides. The tip in the subclavian artery. (The metal tip is no longer in use.) The left inferior thyroid artery forks into two branches, the terminations of the longer and lower one of which run in a marked curve downwards and laterally as if around a tumour; examination of a resected part of the left lower lobe of the thyroid showed adenomatous parathyroid tissue in the parenchyma.

the same as that of the catheter, a needle of 2 mm outer diameter is required. If the catheter is 40—45 cm long it permits a faster injection of the contrast medium than the 12—15 mm needle of 1 mm lumen, used in this department for translumbar aortography.

25 catheterizations were performed by the author and 15 by four other workers in the department.

In one patient catheterization did not succeed, in spite of 3 attempts on the femoral arteries, as sufficient blood-flow through the catheter was not obtained. In one patient no attempt at catheterization was made as resistance to the leader was encountered. In one obese patient, introduction of the catheter into the right femoral artery failed, but was carried out without difficulty on the left side. In the other cases the catheter was inserted easily at the first puncture and the investigation resulted in good films excepting in two cases in which the tip of the catheter did not reach the level required. In one of the patients, 75 years old, resistance was encountered after 6—7 cm, and in another the deep femoral artery instead of the superficial one, was persistently catheterized.

In 6 of the aortographies and in the 3 subclavian arteriographies the catheter was fitted with a metal tip (Fig. 7), but this was abandoned because it was found easier to

Fig. 8. Natural size. The middle needle permits, with the technique described, the insertion of a catheter (in this case No. 205) which requires a needle of the size of that pictured on the left, were it to be passed through the lumen of the needle. The same relative advantage exists between the right and middle needles.

insert the catheter without it, and the artery wall sometimes contracted around it during its removal. Furthermore, it was realized that it might damage the arterial wall as happened in one of the subclavian arteriographies, so that part of contrast medium was injected extravascularly.

As regards complications any tendency to bleed at the site of puncture was unimportant and was mostly observed in elderly patients. No haematoma of clinical consequence ever formed. No thrombosis or any kind of circulatory disturbance in the region of the artery punctured was observed. There was no case of extravascular injection except the one previously mentioned. In the unsuccessful attempts at catheterization, the leader probably passed through the posterior wall of the artery or its intima via a hole made during puncture. In these cases the needle could not be pushed far enough up into the artery. In neither did the patient suffer any ill effects. No kinking or rupture of the catheter, or arterial spasm around it occurred. After local anaesthesia, the patients felt nothing during the manipulations and following the injection of the contrast medium there was, with individual variations, only the wellknown, rapidly passing discomfort.

In one case the patient was operated on two weeks after bilateral femoral catheterization and both arteries were exposed. Traces of blood under the fascia indicated the situation, but the exact site of puncture could not be discerned.

Figs. 3—7 form representative illustrations.

Discussion

The advantage of the author's method of percutaneous catheterization is the smaller size of needle required for a given catheter. As the catheter needs a certain clearance to enable it to glide through the bore of a needle, the difference is more marked than would appear from the thickness of the material (Fig. 8).

In other words, a larger catheter can be inserted by the same sized needle. POISEUILLE's law states that when pressure and viscosity are constant, the rate of flow through narrow tubes is:

inversely proportional to the length of the tube, and

directly proportional to the 4th power of the radius of the tube.

This shows the dominant influence of the cross section of the catheter. Catheter No. 205, used here for abdominal aortography, has an inner diameter, corresponding to a heart catheter No. 9—10. If a pressure

apparatus were used, the gauge might doubtlessly be diminished considerably, *i. e.* to a size No. 160, corresponding to a heart catheter No. 8, and which may be inserted with the help of a needle, 1.5 mm in external diameter.

Though the extra manipulation with the leader is a disadvantage, it is very quickly performed. Furthermore, there is a little risk that the leader, when handled unskilfully, will pass through the posterior wall of the artery, although, no doubt, experience and improved equipment will eliminate this possible complication and avoid failure.

SUMMARY

The author describes a method by which it is possible, after percutaneous puncture, to insert a catheter of the same size as the needle used into an artery.

ZUSAMMENFASSUNG

Der Verf. beschreibt eine Methode, die es ermöglicht, nach perkutaner Punktion einen Katheter von derselben Grösse wie die benutzte Nadel in eine Arterie einzuführen.

RÉSUMÉ

L'auteur décrit une méthode qui permet, après ponction percutanée, d'introduire dans une artère un cathéter de même calibre que l'aiguille utilisée.

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ERRATA

Vol. 39: 5, article "Upward Displacement of the Posterior Part of the Third Ventricle" by GIOVANNI RUGGIERO and FRANCESCO CASTELLANO (May 1953).

Page 381.
Line 13. For "-3.52" read "$+3.52$".
Line 14. For "-3 to -5" read "$+3$ to $+5$".

Page 383.
Lines 7 and 8. For "$-10, -4, -10, -5, -5, -4.0, -2, -3, -1.0, -11, -5$" read "$-10, -4, +10, -5, +5, +4.0, +2, -3, -1.0, -11, +5$".

FROM THE ROENTGEN DEPARTMENT (DIRECTOR: PROFESSOR E. LINDGREN), SERAFIMER-LASARETTET, STOCKHOLM, SWEDEN

UPWARD DISPLACEMENT OF THE POSTERIOR PART OF THE THIRD VENTRICLE

A Method for its Evaluation

by

Giovanni Ruggiero and *Francesco Castellano*

When, as result of a space-occupying lesion, the tension in the posterior fossa increases considerably, its contents tend to herniate. There are two routes of exit: the foramen magnum, through which herniation of the cerebellar tonsils takes place, and the incisura tentorii, through which the brain stem and the superior part of the cerebellum may protrude. The former occurrence, which is the more serious, is radiologically demonstrable only by lumbar encephalography, which may show the inferior pole of the tonsils outlined by air. The latter, on the contrary, is also (and sometimes only) demonstrable by ventriculography through a characteristic upward displacement of the posterior part of the third ventricle. This finding is particularly important in cases where the aqueduct and fourth ventricle are not visualized. Non-filling of the aqueduct and fourth ventricle is very probably due to crushing of the rostral end of the aqueduct against the free margin of the tentorium. Such crushing is not necessarily due to marked upward displacement of the posterior part of the third ventricle; it may also depend on the shape of the posterior fossa (an unusually low incisura tentorii). Such an occurrence does not seem to be exceptional. In a series of posterior fossa meningiomas, we observed non-filling of the aqueduct in four cases (Fig. 1), and the same may occur also in other tumors in the posterior fossa.

Upward transtentorial herniation of the cerebellum in cases of cerebellar tumor was demonstrated by LEBEAU in 1938. Later, the same author, with VINCENT, published the ventriculograms of a cerebellar

Submitted for publication, Sept. 1952.

Fig. 1. Non-filling of the aqueduct and fourth ventricle in a case of meningioma of the posterior surface of the petrous bone. The posterior part of the third ventricle is displaced upward.

tumor, in which the posterior part of the third ventricle appeared to be displaced definitely upwards and the aqueduct and fourth ventricle were not filled. The authors stated that some tumors of the anterior surface of the cerebellum modified the normal aspect of the third ventricle, which was displaced forwards and inclined, but did not show any change in the appearance of its recesses.

The upward displacement of the posterior part of the third ventricle received further emphasis by other authors, among whom are LeBeau, Lysholm, Johnsson and List, Wilson and Lutz, and Ecker. Lysholm as well as Johnsson and List directed attention to the upward displacement of the brain stem in cases of tumors of the pons; Ecker referred principally to acoustic tumors.

The displacement cannot be evaluated at a single glance because the size and shape of the third ventricle, even in normal cases, vary considerably; moreover, one must also take into consideration the shape of the skull, which is likewise variable. To date, two methods have been proposed for the evaluation of the displacement; the method of Johnsson and List, and that of Wilson and Lutz. According to the former, in cases of hydrocephalus, the posterior-inferior portion of the third ven-

tricle should be considered as displaced upward when it is situated above the level of the temporal horns, as seen on a lateral view. This occurs in tumors of the posterior fossa. The contrary (*i. e.* in which the posterior-inferior part of the third ventricle lies below the level of the temporal horns) occurs in non-tumoral hydrocephalus. We used this criterion in a number of cases with conflicting results. Its main deficiency, in our opinion, consists in the fact that it does not take into consideration the variability in the shape of the temporal horns, which may be dilated only slightly, even in cases of marked hydrocephalus.

Considerable reliance seems to be placed in the method of WILSON and LUTZ by some authors. This method consists in drawing a "line along the base of the anterior fossa, *i. e.* the lesser wings of the sphenoid" and a second line "from the anterior clinoid to the suprapineal recess". It was found that the angle included between these two lines, which was usually 140 degrees in normal air studies, was significantly decreased in cases of infratentorial tumors (average 128 degrees, in seven cases), and usually increased in cases of non-neoplastic obstruction of the aqueduct above the tentorium (average 152 degrees, in three cases). These data, however, must be accepted with some reservation: in Figs. 3 and 4 of WILSON and LUTZ' paper their second line does not appear to be directed toward the suprapineal recess, but rather towards the posterior-inferior part of the third ventricle. The authors do not report the number of normal cases in which their method was employed.

In our opinion the method of WILSON and LUTZ is not satisfactory for the following reasons: (1) The plane of the lesser wings of the sphenoid is very irregular and it is almost impossible to draw a line passing through it which is not arbitrary. (2) The authors do not specify to which point of the suprapineal recess the second line must be directed. The shape of the suprapineal recess is very variable: it may be longer than 1—2 cm, or even almost completely missing (Fig. 2). It is obvious that in the former case the angle of WILSON and LUTZ is influenced considerably by whether the line is direct to the beginning or to the end of the recess (Fig. 3). (3) It does not demonstrate the displacement of the posterior part of the third ventricle. For example, in a case of a basal tumor of the middle fossa, the angle would be decreased as in posterior fossa tumors because it is natural, that with upward displacement of the entire third ventricle, the posterior portion is displaced in a similar manner. However, it is just an upward displacement of the posterior part of the third ventricle alone, which occurs in cases of transtentorial herniation of the contents of the posterior fossa. Therefore it would be more accurate to speak of upward displacement of the floor of the posterior part of the third ventricle, as the displacement of the roof is usually of a minor nature or does not occur at all.

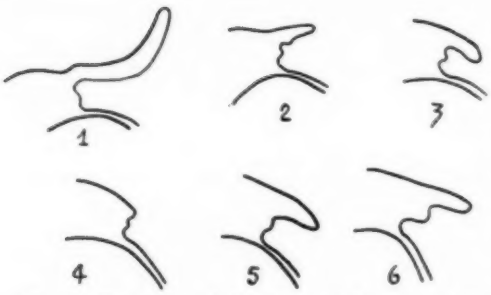

Fig. 2. Examples of the shape of the suprapineal recess. Type No. 5 is the more frequent.

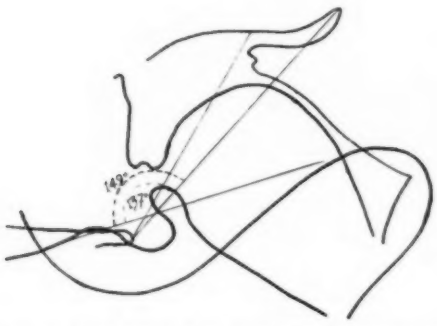

Fig. 3. Variation of the modified WILSON and LUTZ' angle depending on the point (beginning or end of the suprapineal recess) to which the second line is directed (cf. text, p. 2).

From the radiologic point of view, the clivus, as seen on a lateral view, is the most regular and constant plane in the base of the skull; therefore, we have used it in trying a new method. We drew a line perpendicular to the clivus (or to a line which prolongs it upwards) which was also tangential to the anterior-inferior part of the third ventricle. Three possibilities arise: 1. the line passes through the rostral end of the aqueduct (0), 2. above it (+), or 3. below it (—). In our opinion, this method, besides having the advantage of a better bony landmark should enable us to evaluate the position of the posterior part of the third ventricle in relation not only to the base of the skull but also to its anterior portion.

In order to obtain reliable results it is necessary to be sure that both the anterior and posterior parts of the third ventricle are well visualized. Otherwise it is easy to err. (Cfr. p. 2.) Good visualization is usually obtained by concentrating a small quantity of air in the desired part by manipulation of the patient's head. The measurement must not be made directly on the films but rather on a composite tracing from all the roentgenograms.

In 20 cases — ten normal and ten with tumors of the posterior fossa (five intra- and five extra-cerebellar) — we have employed both our method and that of WILSON and LUTZ. The latter method is modified by drawing a first line along the ethmoid-sphenoid plane (not even this plane, though more easily recognizable on the roentgenograms, can be considered as absolutely satisfactory because it is often curvilinear) and a second one directed toward the beginning of the suprapineal recess. The results of this study are tabulated below. The distance between our

second line and the rostral end of the aqueduct was calculated in millimeters.

Normal cases		Posterior fossa tumors	
R & C	W & L	R & C	W & L
0	158	— 10	143
0	160	— 3	161
+ 8	145	— 7	145
+ 2	160	— 12	140
+ 3	145	— 1	160
+ 2	140	— 5	156
+ 3	142	— 4	140
+ 5	180	0	159
+ 10	145	— 2	159
+ 5	167	— 4	155
Average 3.8	149.7	Average — 4.8	151.8

The above data demonstrate that: (1) Our line passes either through, or above, the rostral end of the aqueduct in normal cases, while in tumors of the posterior fossa it passes almost always below the rostral end, and never above it. (2) The modified angle of WILSON and LUTZ is almost the same when averaged for normal cases and for tumors; and, furthermore, the spread of values within both groups is such as to preclude establishing what is a control value in either group. For these reasons, we continued our investigation by employing our method alone. We examined 100 cases grouped as follows:

Normal: 50 cases

Tumors of the posterior fossa (37 cases)
- Extra-parenchymatous
  - Meningioma of the clivus: 2
  - Meningioma of the posterior surface of the petrous bone: 4
  - Meningioma of the cerebellar convexity
  - Meningioma of the tentorium: 7
  - Neurinoma of the acoustic nerve: 4
- Intra-parenchymatous
  - Glioma of the pons: 3
  - Intracerebellar gliomas and angiomas;

Non-tumoral hydrocephalus (13 cases)
- Basal arachnoiditis: 3
- Stenosis of the aqueduct: 10

In normal cases, the average distance between our line and the rostral end of the aqueduct was + 3.52. The most frequent findings were from + 3 to + 5 (26 cases or 50 per cent). In eight cases, the line passed through the rostral end of the aqueduct, and in two cases, 2 mm below it. *The posterior part of the third ventricle has, therefore, to be considered as displaced upward when our line passes below the rostral end of the aqueduct.*

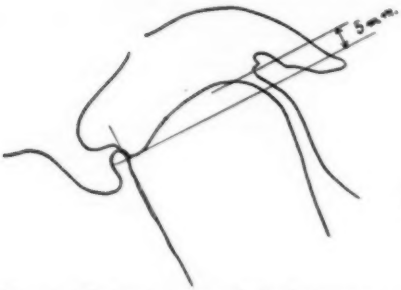

Fig. 4. Moderate upward displacement (5 mm) of the posterior part of the third ventricle in a case of acoustic neurinoma.

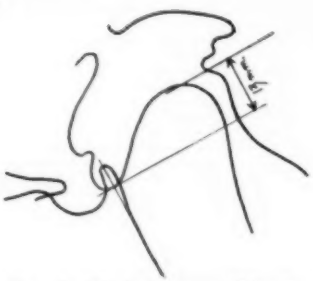

Fig. 5. Marked upward displacement (13 mm) of the posterior part of the third ventricle in a case of intracerebellar angioreticuloma.

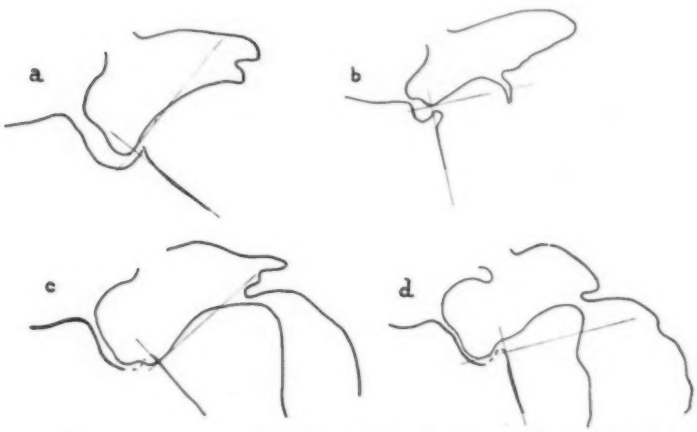

Fig. 6. Examples of non-tumoral hydrocephalus: a and b, stenosis of the aqueduct; c and d, arachnoiditis in posterior fossa.

In tumors of the posterior fossa the average distance was — 4.5. There was, however, a considerable difference between extra- and intraparenchymatous tumors. In the former the upward displacement was much less marked (average — 2.3; Fig. 4) than in the latter (average — 6.7; Fig. 5). The upward displacement was less marked (average — 2.9) in tumors situated in the anterior part of the posterior fossa (13 cases) than in those in the posterior part (24 cases, average — 5.2), but this was probably due only to the prevalence in our material of intracerebellar tumors in which the displacement is usually marked (in one

case — 13, Fig. 5). Our line passed above the rostral end of the aqueduct in only one case: the tumor was a large meningioma attached at the upper portion of the clivus, and had markedly displaced the aqueduct backwards and stretched the third ventricle.

In non-tumoral hydrocephalus the average was — 0.6, but this finding cannot be considered trustworthy since the results were contrasting: — 10, — 4, — 10, — 5, + 5, + 4, 0, + 2, — 3, — 1, 0, — 11, + 5 (Fig. 6). But in cases of this type the knowledge of the position of the posterior part of the third ventricle is of no practical value because the rest of the pneumogram is almost always clear enough to enable one to make the correct diagnosis.

SUMMARY

A method is described for evaluating the upward displacement of the posterior part of the third ventricle, and which was employed in 50 normal cases and 50 cases of lesions in the posterior fossa.

Upward displacement of the posterior part of the third ventricle occurs in all tumors of the posterior fossa, and is more marked in those which are intra-parenchymatous.

ZUSAMMENFASSUNG

Eine Methode, welche es ermöglicht, die Verdrängung des hinteren Abschnittes des 3. Ventrikels nach oben zu beurteilen, wird beschrieben. Sie wurde in 50 Normalfällen und in 50 Fällen mit Läsionen in der hinteren Schädelgrube angewendet.

Aufwärtsverschiebung des hinteren Teiles des 3. Ventrikels tritt bei allen Tumoren der hinteren Schädelgrube auf; sie ist jedoch bei intraparenchymatösen Tumoren stärker markiert.

RÉSUMÉ

Les auteurs décrivent une méthode permettant d'apprécier le déplacement vers le haut de la partie postérieure du troisième ventricule; elle a été utilisée dans 50 cas normaux et dans 50 cas d'affections de la fosse postérieure. Le déplacement vers le haut de la partie postérieure du troisième ventricule se produit dans tous les cas de tumeurs de la fosse postérieure, mais est plus marqué dans celles qui sont intra-parenchymateuses.

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FROM THE 'DIAKONESSENHUIS BRONOVO', THE HAGUE, HOLLAND

THE ROENTGEN DIAGNOSIS OF CALCIFIED ANEURYSMS OF THE SPLENIC AND RENAL ARTERIES

by

J. R. von Ronnen

CRISP, in 1847, described for the first time, a case of an aneurysm of the splenic artery. Since then an increasing number of publications about these aneurysms has appeared. HÖGLER, in 1920, described fifteen cases collected out of the literature. In 1924, BAUMGARTNER and THOMAS found, counting their own case, forty cases in which the diagnosis was certain. HAFFNER, in 1936, arrived at a total of eighty-six cases and in 1947 COSGROVE, WATTS and KAUMP described one hundred and seven of the hundred and forty-four cases recorded in the literature. Reports of aneurysms of the renal artery also have been increasingly frequent in the past two decades. The first publication goes back to that of ROUPPE's in 1770 (the wellknown case of NEBEL, published in 1719, was, according to LOWSLEY and CANNON, incorrectly labelled a renal artery aneurysm, due to erroneous translation; the same authors believe it was an aortic aneurysm). In 1900, KEEN found only twelve cases of renal artery aneurysm in the literature; in 1932, MATHÉ collected fifty-six cases; in 1943, LOWSLEY and CANNON discovered seventy-five cases, and in 1951 ABESHOUSE brought the total up to one hundred and fifteen cases. ABESHOUSE very rightly observes that "the increasing number of new cases reported in the recent literature is an indication that the condition is being diagnosed and reported with greater frequency by urologists and roentgenologists".

As I encountered five cases of calcified aneurysms of the splenic artery or of the renal artery within one year, I came to the conclusion that they were certainly not as rare as one had been led to suppose. This means that the roentgenologist must be on his guard for this possibility and stresses the importance of assessing the significance of such findings with due regard to treatment. In attempting to make this assessment, I have been influenced not only by my own observations but by those collected from the literature at my disposal.

I. Frequency According to Post-mortem Examinations

In 1940, SPERLING published the post-mortem statistics of the Department of Pathology of the University of Minnesota; these covered 33,810 examinations, among which 393 aneurysms were found, 70 being situated

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in the abdomen. The distribution of these 70 abdominal aneurysms was: aorta 48, iliac artery 9, splenic artery 7, coeliac artery 2, renal artery 2, hepatic artery 1 and superior mesenteric artery 1. Of the 7 splenic artery aneurysms, 6 were found incidentally at autopsy and one had ruptured and was the cause of death.

In 1941, SEIDS and HAUSER published a collection of statistics of about 58,000 post-mortems derived from those of VON SCHROETTER, MÜLLER, BOSDORFF, EMMERICH, GARLAND and the Department of Pathology of the Cleveland Hospital. In all, 28 aneurysms of the splenic artery were found. The post-mortem statistics from the Cleveland Hospital covering 12,984 examinations show four aneurysms of the splenic artery, all of which were incidental findings.

Thus a combination of the statistics of the Department of Pathology of the University of Minnesota and of the Cleveland Hospital shows that among 46,704 autopsies, 11 aneurysms of the splenic artery were found and of these, 10 were discovered incidentally at autopsy.

A combination of the statistics of SPERLING and of SEIDS and HAUSER shows a total of 35 aneurysms of the splenic artery in 91,810 autopsies, a frequency of 0.04 per cent.

The statistics covering aneurysms of the renal artery reveal that this condition is much more rare. ABESHOUSE in 1951 published statistics of 100,421 post-mortems gathered from 7 different sources (EMMERICH, BOSDORFF, COMINOTTI, MÜLLER, KMENT, HOWARD, SUBY and HARBERSON, LUCKE and REA). Among these, according to ABESHOUSE, 1,340 aneurysms of which 12 were situated in the renal artery, were found. However, I fear that the combined statistics published by ABESHOUSE are not quite correct because those published by HOWARD, SUBY and HARBERSON were founded on 13,525 post-mortems from the Mallory Institute to which were added the numbers of MÜLLER, EMMERICH and KMENT. KMENT, in 1929, however, published combined statistics of the post-mortems published earlier by VON SCHROETTER, MÜLLER, EMMERICH and BOSDORFF and this means that the figures of MÜLLER and EMMERICH must have been mentioned at least twice.

The following figures would appear to be the correct ones: KMENT, 1929: 41,437 post-mortems with 554 aneurysms, of which five were situated in the renal artery. KMENT gives a combination of the statistics from VON SCHROETTER, MÜLLER, EMMERICH and BOSDORFF.

HOWARD, SUBY and HARBERSON, 1941: 13,525 post-mortems from the Mallory Institute, Boston, among which one aneurysm of the renal artery was found.

SPERLING, 1941: 33,810 post-mortems with 393 aneurysms, of which two were situated in the renal artery.

The total is therefore 8 aneurysms of the renal artery in 88,772 post-mortems, an incidence of about 0.01 per cent.

As a rough estimate we may state that aneurysms of the splenic artery are about four times more often encountered than aneurysms of the renal artery.

I have not been able to find data about the number of renal artery aneurysms found incidentally in post-mortem statistics.

II. Pathogenesis and Etiology

(a) *Splenic artery aneurysm.*

PALMER differentiates three major causes for the genesis of a splenic artery aneurysm:

1. Arteriosclerosis. The arteriosclerotic aneurysms occur most frequently and are characterized by atheroma formation and calcifications in the wall of the aneurysm. They mostly are found in the main trunk of the artery.

2. Mycotic aneurysms. These are usually caused by an embolus originating from vegetations of the heart valves and are generally found in the branches of the splenic artery.

3. In some cases the cause of the aneurysm is believed to be a congenital defect in the wall of the artery. This type of aneurysm is most often situated at the bifurcations of the artery.

Several authors consider arteriosclerosis as one of the most important causes of splenic artery aneurysm (SHERWIN and GORDIMER, MACHEMER and FUGE, HAFFNER and SÄFVENBERG).

The theory of mycotic aneurysms complicating rheumatic valvulitis also finds many defenders: SHERWIN and GORDIMER, MACHEMER and FUGE, SÄFWENBERG, HUNT, BAUMGARTNER and THOMAS.

The belief that a congenital defect in the wall of the artery can be a cause of the genesis of an aneurysm is rather old. In 1903 TARROZZI (quoted by MACHEMER and FUGE) described an aneurysm of the splenic artery and noted the absence of any elastic membrane. He believed that localized collections of elastic tissue with intervening areas devoid of such tissue might be a causative factor. SCHUSTER (quoted by MACHEMER and FUGE) stated that aneurysm of the splenic artery might be another manifestation of inborn vascular defects. The original suggestion he attributed to EPPINGER. In 1941, RICHARDSON and HYLAND in a detailed publication traced the part that congenital defects play in the cause of cerebral aneurysms; they found that these latter are produced in many instances by defects in the elastic tissue of the medial coat of the arteries at the apex of the angle formed by their bifurcation. LOWSLEY and CANNON championed this theory as being a causative factor also in aneurysms of the renal artery.

The objections against the congenital theory are: (a) most of the splenic artery aneurysms are not situated at the bifurcations of the artery but along its main trunk (BAUMGARTNER and THOMAS) and (b) these aneurysms are comparatively little heard of in young persons (MACHEMER and FUGE: "most of the splenic artery aneurysms occurred in the 3rd decade of life").

As less important causes may be added:

4. Trauma. Of this PALMER writes: "Four cases following trauma have been reported, but in only one (MARSHALL's case: direct gunshot injury) is there any definite evi-

dence of the causal relation." According to BAUMGARTNER and THOMAS the case of HARNETT (abdominal trauma three years previously, shortly following which the first symptoms appeared) should also be regarded as traumatic in origin.

5. Pregnancy. Splenic artery aneurysms have a predilection for becoming manifest during pregnancy. LENNIE and SHEEHAN collected twenty cases of rupture during the period of gestation; almost all of these occurred towards its termination. They observed that there is an important difference in the frequency of splenic artery aneurysm in men and women before the 45th year; of the 94 cases collected by these authors, 34 occurred in females against 12 in males before the 45th year, whereas after the 45th year the difference disappeared and the frequency was almost the same: 24 cases in females against 20 in males. The age of 45 years was chosen as representing the end of the childbearing period.

As a possible explanation of this phenomenon, LENNIE and SHEEHAN presume that the combination of auto-intoxication during pregnancy and increased blood pressure might be a causative factor in the development of splenic artery aneurysms.

It is indeed very remarkable that LENNIE and SHEEHAN found the opposite to be true in aneurysms of the renal artery. They collected 66 cases of renal artery aneurysms of which, before the 45th year, 21 occurred in males and 7 in females; after the 45th year, this difference in frequency disappeared and they found 18 and 20 cases in males and females, respectively.

(b) *Renal artery aneurysm.*

The etiology of aneurysm of the renal artery is described in detail by ABESHOUSE. This author mentions:

1. The congenital theory. A congenital factor is particularly favoured by LOWSLEY and CANNON. ABESHOUSE, however, remarks that there are certain objections to it, *i.e.* renal artery aneurysms are usually not situated at the bifurcations but more often in the branches of the artery and furthermore, that these aneurysms do not generally occur in young persons.

2. Arteriosclerosis. Only 12 of the 75 cases reviewed by LOWSLEY and CANNON were associated with arteriosclerosis and only an additional 4 cases in the 40 subsequently collected. In other words: in only 13 per cent of these cases could arteriosclerosis be looked upon as the cause.

3. Inflammatory lesions in the wall of the renal artery appear to be an infrequent cause. In the 115 cases reviewed by ABESHOUSE, syphilis was regarded as the etiologic factor in four, periarteritis nodosa in three, rheumatic endarteritis in one and tuberculosis in one case.

4. Trauma. It appears that trauma is a primary etiologic factor in relatively few cases but serves as an important secondary or predisposing factor in many; this is by virtue of the local injury and weakness produced in the renal artery wall which predisposes to subsequent dilatation and aneurysm formation.

5. In addition to the causes mentioned, ABESHOUSE describes the following possibilities: "a localized area of weakness in the wall of the renal artery may be conceivably the result of (a) traction or angulation of the renal artery by a kidney which is abnormally displaced as a result of ptosis or enlargement. This is similar to a traction aneurysm of the aortic arch described by THOMA; (b) long-standing compression of the renal artery by renal enlargement, or tumour mass; (c) compression of the renal artery by abdominal viscera, tumours etc., and (d) temporary or permanent constriction of the renal artery due to intrinsic neurogenic disturbances."

If we consider the etiology of both types of aneurysms together we find a very confused picture and it appears difficult to find causative factors equally applicable to splenic and to renal artery aneurysms. Arteriosclerosis which is the most important etiologic factor in splenic artery aneurysms is only the cause in 13 per cent of aneurysms of the renal artery. While a splenic artery aneurysm is considered often to be mycotic in origin, this cause in the formation of a renal artery aneurysm is relatively insignificant. In regard to the congenital theory, agreement prevails in so far that this may possibly be an explanation in a small though certainly not large number of cases. Trauma plays a very small part in the formation of a splenic artery aneurysm, while in the case of an aneurysm of the renal artery, it is considered an important, although not a direct, cause. Why, during pregnancy, a splenic and not a renal artery aneurysm has a tendency to arise or to become manifest, is obscure.

III. Classification

A distinction is generally made between an aneurysma verum and an aneurysma spurium. The former is defined as a localized dilatation of an artery retaining one or more of the original coats. An aneurysma spurium is one whose walls are derived from tissues originating outside the artery.

In a pathologic sense only the aneurysma verum is an aneurysm; WESSON therefore calls an aneurysma spurium an arterial haemorrhage confined by the surrounding tissues.

In the following remarks, I restrict myself to the aneurysma verum (true aneurysm) of the splenic and renal artery, as being of a type more important to the roentgenologist.

IV. Symptomatology

For a detailed description of the clinical pictures of splenic artery aneurysm the reader is referred to the excellent publications of HÖGLER, SEIDS and HAUSER, SHERWIN and GORDIMER, MACHEMER and FUGE, and PALMER. For aneurysms of the renal artery, reference may be made to the likewise admirable description by VOGELER, MATHÉ, GÉRARD, LOWSLEY and CANNON, LAZARUS and MARKS, and ABESHOUSE. Generally speaking, most writers stress the fact that a rupture may simulate almost any acute abdominal condition. The final clinical picture is that of a severe internal haemorrhage.

V. Roentgen Aspects

KEY and ÅKERLUND were the first to describe the roentgen appearances of a calcified aneurysm of the renal artery.

In 1926, RENCK gave a detailed description of the roentgen signs of calcified aneurysms of the renal artery. He stated that the appearance is that of a round or oval ring-shadow with the following characteristics (a) a well-defined periphery exhibiting an increased density compared with the less opaque centre, (b) an occasionally demonstrable loss of continuity at the point where the aneurysmal sac communicates with the artery and (c) a typical situation in the hilar region of the kidney, outside the renal pelvis although so near to it that the latter sometimes shows a deformity caused by the impression of the aneurysm. Since this description, not much has been added to the characteristic roentgen features.

The position of the calcification in relation to the renal pelvis may be determined with the help of urography or pyelography. It is usually found lying outside the pelvis in the angle between the upper border of the pelvis and the medial border of the superior calyx major.

Nowadays other roentgenologic methods such as laminography and aortography enable us to make the diagnosis with more certainty.

LEVINE was one of the first who determined the position of the opacity in relation to the kidney by means of laminography. In addition, laminography has other possibilities. One of the most essential roentgen features of a calcified aneurysm is the loss of peripheral continuity at the point where the aneurysmal sac communicates with the artery. Such a loss of continuity may, or may not be seen in conventional films (Fig. 4 a). In the latter case I have been able to locate the defect by laminography and thus support the diagnosis (Fig. 3 b).

Aortography is, without any doubt, the ideal method of demonstrating the position and relation of the aneurysm to the renal artery; it is also the only method of determining with certainty from which artery the aneurysm has its origin.

As early as 1931, DOS SANTOS, LAMAS and CALDAS in their classical work "Artériographie des Membres et de l'Aorte Abdominale", pointed out the importance of aortography in demonstrating aneurysms of the abdominal arteries. However, it is only in recent years that the method has been gaining ground as a method of examination. WAGNER, in 1946, described a case with a ring calcification in the left kidney area. Aortography showed the shadow filled with contrast medium but without communication to the left renal artery. Autopsy several months later revealed that the opacity was caused by an aneurysm of the splenic artery. This case proves the importance of aortography, especially in cases in which doubt exists about the exact location of the aneurysm and in which surgery is being considered.

ABESHOUSE has described (1951) two cases in which aortography affirmed the diagnosis of a calcified aneurysm of the renal artery. In

most instances, however, it is possible, by making full use of routine roentgenography, to establish the correct diagnosis.

LINDBOE in 1932 was the first to publish a case of calcified aneurysm of the splenic artery in which a correct diagnosis was made preoperatively by roentgen examination and verified at operation. Before this, three cases of a similar nature were published, but the diagnosis was either not verified at operation (RICCI 1930, ISRAELSKI 1930) or not made preoperatively (TIXIER, BAUMGARTNER, RONNEAUX and GADREAUX 1930). HAFFNER, in 1936, described in an article with excellent illustrations the roentgen aspects of a calcified aneurysm of the splenic artery. Apart from the situation, the description completely corresponds with that of a calcified aneurysm of the renal artery. The calcification is situated in the left hypochondrium at the level of T. 12 or L. 1, posterior or postero-medial to the pars media ventriculi and superior to the upper pole of the kidney. HAFFNER points to the fact that the nearer the aneurysm is to the spleen the more readily it follows the movements of the diaphragm. Since HAFFNER's contribution a number of articles have been published without, however, adding important new aspects to the roentgen picture.

Laminography also represents an important gain in the roentgen diagnosis of a calcified aneurysm of the splenic artery (Cases 3 and 5).

Aortography is, as a matter of fact, the ideal method of establishing the diagnosis with certainty. More than once a splenic artery aneurysm was found accidentally during aortography (WAGNER, PRICE and SWENSON one case, 1947; SMITH, EVANS, ELSEY and FELSON two cases, 1952).

VI. Roentgenologic Differential Diagnosis

The roentgenologic differential diagnosis of a calcified aneurysm of the splenic artery includes:

1. A calcified aneurysm of the left renal artery. In most cases discrimination is possible by the fact that a renal artery aneurysm is situated in the renal hilus, near to the renal pelvis, and not displaced significantly with respiration. Difficulties arise when a left renal artery aneurysm is situated, not in the hilar region, but more in the direction of the aorta; differentiation is then impossible without aortography.

2. A calcified echinococcus cyst situated in the spleen, the left lobe of the liver or in the mesentery. Echinococcus cysts mostly are multiple and may occupy a diversity of sites; an increased number of eosinophils may be found in the blood: the intracutaneous reaction of Casoni may be positive; the absence of a loss of continuity of the wall of the ring-shadow, if examined by laminography in several directions, is against a

calcified aneurysm. In doubtful cases aortography will provide the solution.

3. Pancreatic calculi, calcified mesenteric lymph nodes, phleboliths in the spleen, calcified infarctions in the spleen, calcified tuberculous foci in the spleen and calcifications due to perisplenitis present quite a different roentgen picture and can hardly be mistaken for a calcified aneurysm.

4. A calcified cyst of the spleen. The wall shows no loss of continuity if the cyst has a uniformly calcified wall; the wall is rather thin in relation to the size of the cyst. In doubtful cases aortography should be performed.

The roentgenologic differential diagnosis of a calcified aneurysm of the renal artery includes:

1. Calcified aneurysms of the splenic, hepatic, pancreatic and mesenteric arteries. These may be distinguished by their situations. Aortography will enable us to determine with certainty the artery from which the aneurysm has its origin.

2. A renal calculus is seldom laminated. Urography is, however, sometimes necessary for an exact diagnosis.

3. Gallstones. The laminated solitary gallstone can resemble a calcified renal artery aneurysm. Differentiation is usually easy by means of cholecystography.

4. A calcified renal cyst, if uniformly calcified, shows no loss of continuity of the wall as occurs in a calcified aneurysm. The wall is rather thin in comparison to the size of the cyst.

5. Calcified mesenteric lymph nodes generally exhibit considerable mobility, irregular outline and density and are mostly multiple.

6. Calcifications in tumours of the kidney and calcified tuberculous foci in the kidney produce roentgen signs which can hardly be mistaken for a calcified aneurysm of the renal artery.

Though the diagnostic points of calcified aneurysms of the splenic and the renal arteries have been described in some detail, I am convinced that in most instances their recognition will present no difficulties. However, identification of the artery to which the aneurysm belongs may be hard and sometimes only aortography can provide the solution.

Echinococcus cysts may present roentgen appearances which look deceivingly like those of calcified aneurysms. In regions where the possibility of an infection with echinococci exists or if a patient has been in such a region, this fact will have to be kept in mind.

VII. Therapy

The surgical removal of these aneurysms involves splenectomy or nephrectomy in almost all cases. The fact that within one year I have found five patients with one or more calcified aneurysms of the splenic or renal artery is an indication that these conditions are not so rare as believed. If this is true, it is surprising that there are so few reports of spontaneous rupture. This indicates that the chance of such an occurrence is small, and that surgical therapy will not be necessary in many cases.

A review of the literature reveals that most recent authors advise removal of a splenic artery aneurysm as soon as the diagnosis is made (PALMER, SHERLOCK and LEARMOUTH, SHERWIN and GORDIMER, BAUMGARTNER and THOMAS). The reason for this rigorous point of view is that the therapeutic results, once rupture has occurred, have been disheartening. PALMER found recovery after operation reported in only three cases in which rupture had taken place (BROCKMAN 1930, GILLAN 1942, MORSE and COVERT 1947).

Concerning the therapy of aneurysm of the renal artery ABESHOUSE states: "The potential danger of spontaneous or traumatic rupture with its dire consequences and fatal termination does not justify a conservative policy." HOWARD, SUBY and HARBERSON, BERNEIKE and POLLOCK, MATHÉ, LAZARUS and MARKS, LOWSLEY and CANNON are of the same opinion.

In quite a few earlier publications a less rigid standpoint is taken. According to SÄFWENBERG, small calcified splenic artery aneurysms are innocent. He bases this opinion on the fact that among 25 fatally terminating ruptures of splenic artery aneurysms (out of a collection of 59 published by ANDERSON and GRAY) 19 were of the size of a walnut or bigger; the size was not stated in the remaining 6 cases.

SÖDERLUND, in discussing calcified renal artery aneurysms, writes: "In aneurysms as sequelae of arteriosclerosis, the risks of spontaneous rupture are by no means great. Experience shows that small renal aneurysms may persist without giving rise to any symptoms whatever and are only disclosed as incidental findings at autopsy." RENCK, CALLAHAN and SCHILTZ, HOWARD, SUBY and HARBERSON express the opinion that rupture of a calcified renal artery aneurysm is unlikely.

That small aneurysms may rupture is, however, proved by the cases of ROWLANDS and CHISHOLM, in both of which pea-sized renal artery aneurysms were present. In ROWLANDS' case a spontaneous rupture occurred, in CHISHOLM's the aneurysm ruptured during the last months of pregnancy. Neither of these aneurysms was calcified.

The case published by BARNARD (quoted by GÉRARD) shows that a calcified aneurysm may be markedly resisting: a boy, 9 years old, fell off a horse and died shortly afterwards from intraperitoneal haemorrhage. Autopsy revealed that the haemorrhage was caused by a rupture of the liver; this rupture originated from the forcing in of a hazel-nut sized calcified aneurysm of the right renal artery into the liver by the trauma. The aneurysm itself was not ruptured!

No cases of ruptures of calcified splenic or renal artery aneurysms are reported in the literature.

The combined post-mortem statistics of the Cleveland Hospital and the Department of Pathology of the University of Minnesota show eleven splenic artery aneurysms, ten of which were found incidentally at autopsy.

On account of all these arguments a policy of watchful expectancy is considered justified in our Hospital if the aneurysm (a) is small (size of a cherry or smaller), (b) shows a completely calcified wall, except for

the loss of continuity that indicates the communication of the sac with the artery, (c) is asymptomatic, (d) is not combined with severe hypertension and (e) is found in a female beyond the child-bearing period.

As soon as an aneurysm gives rise to symptoms, or even if it is doubtful whether or not the symptoms originate from the aneurysm, radical surgical therapy has to be performed.

Case Reports

Case 1. v. d. P. Female, aged 62. Roentgen examination of the lumbar spine because of pain in back and right side, revealed spondylosis deformans, a cherry-sized ring calcification in the left hypochondrium at the level of Th. 12 and another, pea-sized, in the hilar region of the right kidney. Both opacities showed a well-defined dense periphery and a less opaque mottled central portion. There appeared to be a stalk arising from the lateral aspect of the first opacity (Fig. 1 a—b), which was situated above and lateral to the upper pole of the left kidney and moved on respiration.

Urography disclosed no abnormalities. The calcification on the right side was visible in the angle between the upper wall of the pelvis and the inner wall of the superior major calyx just outside the pelvis (Fig. 1c). A barium meal examination showed the shadow on the left side to be lying posterior to the pars media ventriculi and causing a slight impression in the posterior wall of the stomach.

Conclusion: Calcified aneurysms of the right renal and splenic arteries.

Clinical examination of the patient revealed no abnormalities. Blood pressure, 150/70. Wassermann, negative. Although there was doubt whether the patient's symptoms were to be attributed to the aneurysms or to the spondylosis deformans, it was considered safer to remove the former. Right nephrectomy was therefore performed and followed later by splenectomy and removal of the aneurysm of the splenic artery (WIJNEN). This aneurysm was found to be arising from the main artery about two inches proximal to its bifurcation and was depicted clearly in a roentgenogram of the specimen. (Fig. 1 d.)

About one year later, the pain in the back and right side had disappeared — a fact suggesting that it may possibly have originated from the aneurysms.

Case 2. A. Male, aged 64. In July 1951 the patient entered the Hospital for the surgical treatment of a testicular hydrocele. Two weeks after the operation he complained of severe pain in the lower part of the abdomen.

As an ileus was suspected, a plain film of the abdomen was taken, and in which a tortuous widened and calcified splenic artery ending in an oval dilatation was seen in the left hypochondrium medial to the splenic flexure (Fig. 2).

The abdominal pain slowly disappeared; as its origin had not been discovered, a roentgen examination of the stomach and small bowel was performed and proved normal. The tortuous calcified splenic artery was found to be lying posterior to the pars media ventriculi, the posterior wall of the stomach showing two slight impressions at its level.

Clinical data: Definite peripheral arteriosclerosis; B. P. 165/90; urine analysis: albumen 0.1 per cent, urobiline ++; the blood serum gave a raised urea content (676 mgm/L); Wassermann reaction, negative; spleen, enlarged.

The cause of the abdominal pain remained obscure. We gave serious consideration to the possibility that the symptoms could have had their origin from the aneurysmal

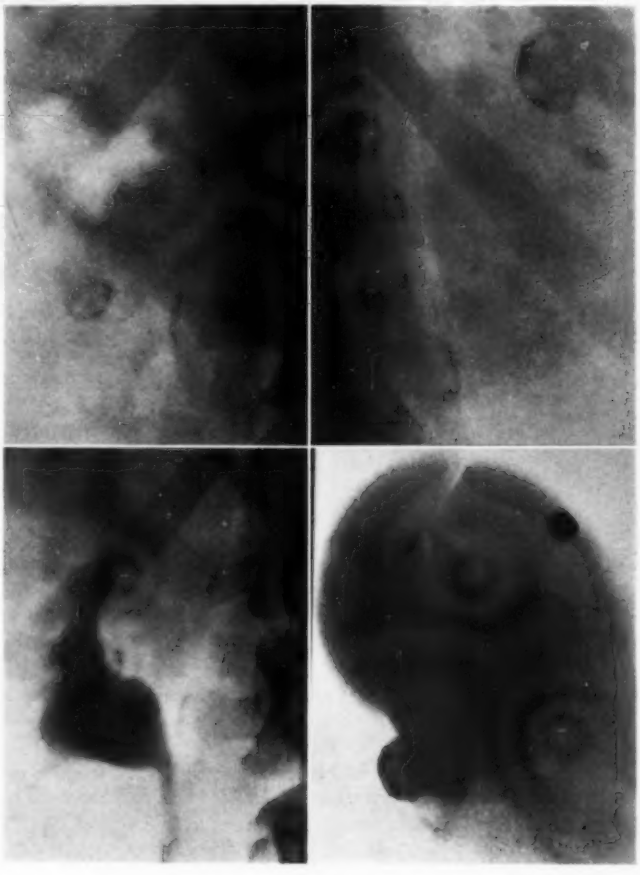


Fig. 1, Case 1: (a) Pea-sized ring-shadow in the hilar region of the right kidney. — (b) Cherry-sized ring-shadow in the left upper quadrant. — (c) The ring-shadow on the right side is visible between the upper wall of the pelvis and the medial border of the superior calyx major. — (d) Roentgenogram of the removed spleen with aneurysm; note phleboliths.

condition of the calcified splenic artery by causing infarctions in the spleen, but owing to the extensive arteriosclerosis and indifferent general health, any question of surgical therapy was abandoned.

After some time the patient was discharged in fairly good condition.

Case 3. v. d. K. Female, aged 59, was referred to the roentgen department complaining of pain around the left lower ribs anteriorly, following trauma.

Fig. 2. Case 2: Tortuous widened and calcified splenic artery in left upper quadrant.

The A. P. roentgenogram revealed no abnormalities of the ribs. At the level of Th. 12 two ring shadows were found lying medial to the spleen. One was rounded and about the size of a large marble and lateral to it lay the second shadow, oval in shape and about the size of an almond with a distinct stalk on its lateral border. Both shadows showed dense well-defined peripheries and mottled central zones; they were situated superior to the upper pole of the left kidney (Fig. 3 a). In the lateral view both shadows were projected ventral to the vertebral column. They moved on respiration. The visible stalk of the lateral shadow was typical of a calcified aneurysm. With the help of laminography a loss of continuity in the wall of the medial ring-shadow at a distance of 9.5 cm from the left flank was demonstrated. (Laminography in sagittal planes) (Fig. 3 b.) Close inspection of this section revealed a small stalk-like calcification at the site of the defect. Frontal laminography revealed no loss of continuity in the calcified wall (Fig. 3 c).

Conclusion: Two calcified aneurysms of the splenic artery. There had been no symptoms attributable to them and as they were small and calcified, surgical intervention was not advised.

Case 4. B. Female, aged 74, admitted in January 1952 with a month's history of pain in the left lumbar and hypochondriac regions. She also suffered from constipation.

Clinical examination revealed a tender resistance below the right lobe of the liver, moving on respiration. The patient denied ever having had any persistent pain on the right side.

The sedimentation rate was rather high (12—38); B. P. 220/130. Wassermann, negative. Urine analysis, normal. She was referred to the Roentgen Department for examination of the gall bladder, stomach and colon. In the films an oval ring-shadow was found on the right side at the level of L. 2. There was a well-defined dense periphery and a less opaque centre, with a loss of continuity of outline medio-inferiorly, where a small stalk-like calcification was visible (Fig. 4 a). The size of the opacity was about that of a cherry.

In the A. P. view the opacity was situated about an inch above the medial border of the upper pole of the right kidney, which lay at the level of L. 3. In the lateral view the shadow was projected onto the anterior border of the vertebrae, but no loss of continuity of the periphery was visible (Fig. 4 b); calcification of the walls of the abdominal aorta was noted.

Fluoroscopic examination of the thorax revealed moderate enlargement of the left

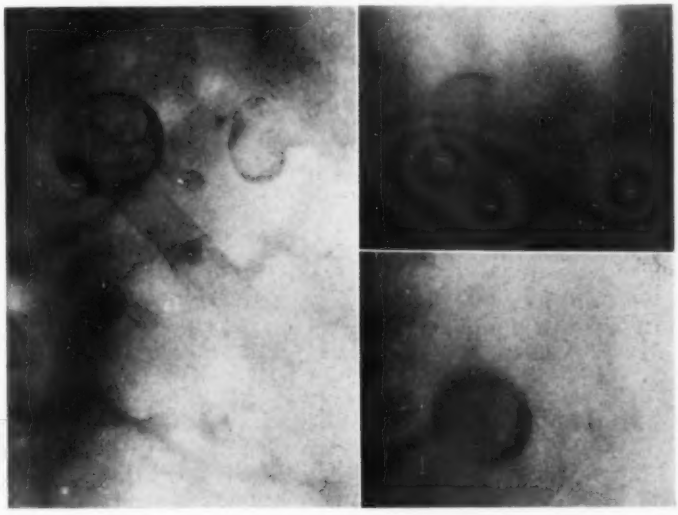


Fig. 3, Case 3: (a) Two ring-shadows in the left upper quadrant; stalk on lateral opacity. — (b) Laminogram in sagittal plane of the medial ring-shadow shows a distinct loss of continuity of the wall at 9.5 cm from the left side. — (c) Laminogram in frontal plane of the medial ring-shadow shows no loss of continuity of the wall.

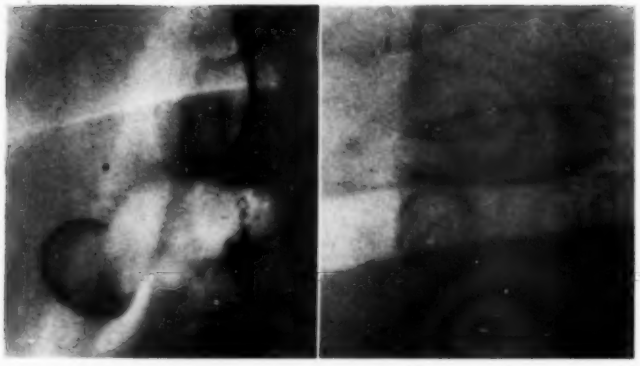
ventricle, a distinct elongation of the aorta and extensive spondylosis deformans of the vertebrae.

Conclusion: Calcified aneurysm, most probably of the right renal artery. That this is the site of the aneurysm is likely from its situation at the level of L. 2 and its projection in the lateral roentgenogram onto the ventral border of the lumbar vertebrae. The possibility of a calcified aneurysm of the hepatic or superior mesenteric artery should be considered, though one would expect such an aneurysm to be projected on the lateral view ventral to the lumbar vertebrae.

Aortography would have been the only method of locating the aneurysm with certainty, but was omitted because of the high blood pressure, the extensive arteriosclerosis and age of the patient.

The cholecystographic findings were suggestive of pathology of the gall-bladder, but our hopes of defining the aneurysm during the proposed cholecystectomy vanished when surgical treatment was refused.

Although the patient complained exclusively of pain in the left hypochondrium and the left lumbar region this does not necessarily mean that it was unconnected with the aneurysm. KMENT published a case in which the patient complained of pain of a colic character on the right side. Roentgen examination of the abdomen revealed a ring-shadow in the left kidney hilum. The pre-operative diagnosis was 'laminated calculus'. On operation the lesion proved to be a calcified aneurysm of the left renal artery. KMENT explained this phenomenon by reno-renal reflex (THORNTON, GUYON et al.). SPERLING described a case of a patient who had had colic on the right side. Roentgen examination



a. b.

Fig. 4, Case 4: (a) Oval ring-shadow showing a loss of continuity of the medial wall on right side at level of L. 2. — (b) In the lateral view the ring-shadow is projected on the ventral portion of the vertebral column. No loss of continuity of the wall in this projection.

revealed a calcified aneurysm of the splenic artery. On operation two calcified aneurysms of the splenic artery were found.

Though in our case, the pain and hypertension seemed to indicate surgical removal of the aneurysm as being a wise procedure, it was prevented by the refusal of the patient to undergo operation.

Case 5. S. Female, aged 71, was sent to the roentgen department for examination of the left lower ribs shortly following trauma No abnormalities of the ribs were found. Lateral to Th. 12 and medial to the spleen a calcified ring-shadow about the size of a marble was visible and moved on respiration. In the lateral view, it was projected ventral to the vertebral column. Laminography (frontal) demonstrated a distinct loss of continuity of the periphery of the shadow which was situated 11 cm from the posterior skin surface.

Conclusion: Calcified aneurysm of the splenic artery. As the patient had never had any symptoms referable to the aneurysm, we saw no reason for surgical interference.

SUMMARY

A review is given of the literature concerning the frequency, pathogenesis, roentgenologic diagnosis and treatment of aneurysms of the renal and splenic arteries.

The case histories of five patients, recorded within one year, in which one or more calcified aneurysms of the splenic or renal arteries were roentgenologically diagnosed, are presented and discussed. It would appear that these aneurysms are not so rare as is generally supposed. Contrary to the usual opinion that all such aneurysms should be removed, an exception is proposed in the case of small calcified aneurysms causing no symptoms if no significant hypertension exists, and in women, beyond the child-bearing period.

ZUSAMMENFASSUNG

Ein Literaturüberblick hinsichtlich der Frequenz, der Pathogenesis, der Röntgendiagnostik und der Behandlung von Aneurysmen der Aa. renales und Aa. lienales wird gegeben.

Die Krankengeschichten von 5 Patienten, die innerhalb eines Jahres registriert und bei denen ein oder mehrere Aneurysmen der Milz- oder Nierenarterien röntgenologisch diagnostiziert wurden, werden wiedergegeben und diskutiert. Es macht den Eindruck, als seien diese Aneurysmen nicht so selten wie es allgemein angenommen wird. Im Gegensatz zu der gewöhnlichen Ansicht, dass alle derartigen Aneurysmen entfernt werden sollten, wird eine Ausnahme für Fälle mit schmalen verkalkten Aneurysmen, die ohne Symptome verlaufen und bei denen keine signifikative Hypertonie besteht, sowie für Frauen in der Menopause gemacht.

RÉSUMÉ

L'auteur fait une revue de la littérature sur la fréquence, la pathogénie, le diagnostic radiologique et le traitement des anévrysmes des artères rénales et splénique.

Il présente et commente les observations de cinq malades, recueillies en un an, dans lesquelles un ou plusieurs anévrysmes calcifiés de l'artère splénique ou des artères rénales ont été diagnostiqués radiologiquement.

Il semble que ces anévrysmes ne soient pas aussi rares qu'on le croit en général. Contrairement à l'opinion habituelle que tous ces anévrysmes doivent être enlevés, l'auteur propose de faire une exception dans le cas des petits anévrysmes calcifiés asymptomatiques quand il n'y a pas d'hypertension importante, et chez les femmes qui ont dépassé l'âge des grossesses.

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FROM THE DEPARTMENT OF ANATOMY, WAYNE UNIVERSITY, DETROIT, MICHIGAN, U. S. A.

EPITRIQUETRUM, HYPOTRIQUETRUM, AND LUNATOTRIQUETRUM

by

Ronan O'Rahilly

Medial Intercarpal Space

A variable interval is found between the lunate, triquetral, capitate, and hamate bones of the carpus. It has been referred to by the French as the 'space of Destot' (BARBET, 1948) and will be termed here the 'medial intercarpal space' (fig. 1). (However, no mention of it as such was noticed in "Injuries of the Wrist; a Radiological Study" by DESTOT (1925). The radiographic appearance of the space is of diagnostic interest in carpal dislocations.)

An interval which may be termed the 'lateral intercarpal space' is sometimes seen between the scaphoid, capitate, and trapezoid. The commonest form is an indentation on the lateral side of the capitate (fig. 10) which has been called 'canalis dorsovolaris carpi' by VIRCHOW (1929). In 839 hospital carpal radiographs examined by the present writer such a definite notch was observed in 83 instances (9.9 %). The dorsopalmar 'canal' is generally assumed to be the site of a degenerate or unossified os centrale. SPEED (1925) refers to the possibility of incomplete fusion of two capitate centres. Multiple carpal ossification (apart from hypothyroid epiphyseal dysgenesis) is excessively rare, however; ADAIR and SCAMMON (1921) in roentgenograms of 100 newborn infants found one instance of 'bifid' capitate and two cases of double centre for the capitate — in one case the centres appear to have been medial and lateral, in the other superolateral and inferomedial.

Although the medial intercarpal space is not commented on in current American and British textbooks, the interval was observed by T. H. BRYCE (1896) in a roentgenogram of his own hand taken only a few months after the discovery of roentgen rays.

"Its tip [that of the hamate] fails to reach the lunar, and there is an angular interval between it and the pyramidal [triquetral]."

Submitted for publication, April 25, 1952.

The medial intercarpal space was referred to also by JOHNSTON (1907) who indicated its altered appearance in different movements of the carpus; he, and later WRIGHT (1935), pointed out that the hamate and lunate approach each other in adduction and become separated again in abduction of the hand.

The curved ridge on the lunate which articulates with the hamate is very variable and inconstant and when it is absent these two bones do not articulate with each other (POIRIER and CHARPY, 1926). Indeed according to WOOD JONES (1941) the articulation is only 'occasional' and "very often the unciform [hamate] and semilunar [lunate] are widely separated in all positions that the carpus can assume", thus forming the medial intercarpal space referred to above.

Intercarpal interstices of this type are filled with intra-articular synovial folds (GRANT, 1930—31). Protrusions of synovial tissue arise at an early stage of embryonic life. Villi have been found in the human knee-joint at 49—50 mm (GRAY and GARDNER, 1950), in the elbow joint at 60 mm (GRAY and GARDNER, 1951) and in the hip joint at 106—107 mm (GARDNER and GRAY, 1950). The present writer has found the medial intercarpal space well-defined in the human embryo at 17 mm C. R. and occupied by tags of vascular connective tissue by 100, 110, 126, 140, and 170 mm stages.

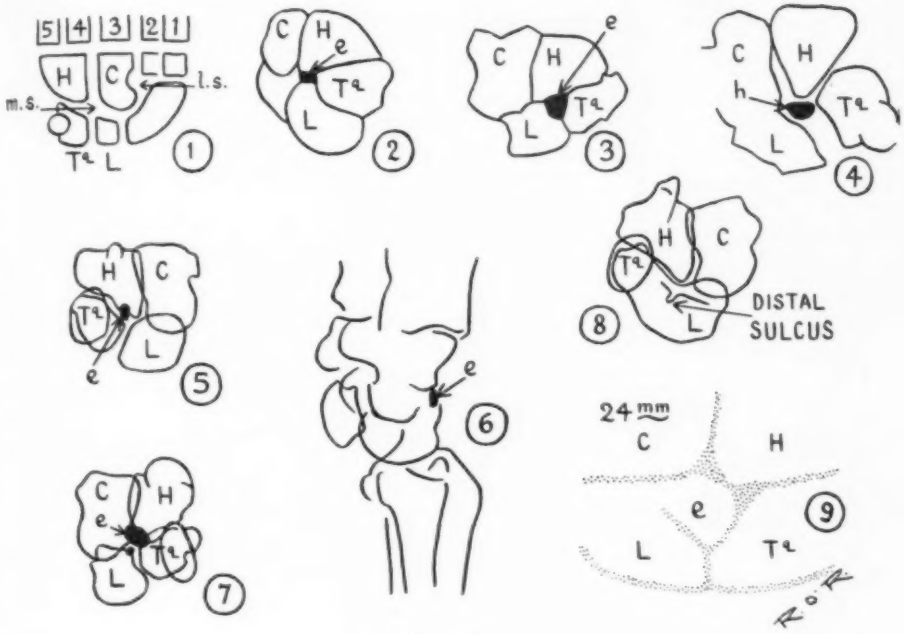
Epitriquetrum and 'Hypotriquetrum'

It is a characteristic of most of the intercarpal (intertarsal) and carpometacarpal (tarsometatarsal) interstices that small bones, variously termed accessory ossicles or sesamoids, are sometimes found at these sites. Many topographic types have been described (see O'RAHILLY, 1953).

Two rare ossicles, one palmar and one dorsal, have been found in or near the medial intercarpal space. The dorsal ossicle is known as the os epitriquetrum.

The term 'triquetrum' is due to ALBINUS, 1726. This bone, originally called 'cuneiforme' by LYSER, 1653, was referred to as 'pyramidale' by HILDEBRANDT. In the present article the Birmingham Revision (1933) of the Basle Nomina Anatomica (1895) is used. 'Epitriquetrum' is preferable to the term 'epipyramis' (used by PFITZNER, 1900) since both the B. N. A. and the B. R. use 'triquetrum'. THILENIUS classified the epitriquetrum as 'centrale 4'; terms of this type should be avoided, as they involve the user in unsubstantiated theories.

It is proposed here to call the palmar ossicle the 'os hypotriquetrum', since dorsal and palmar loci are used elsewhere (cf. epilunatum and hypolunatum) as a criterion of distinction in the classification of accessory ossicles. The case dissected by SAUNDERS (1942) appears to be the only definite instance yet recorded.



Figs. 1—9.

Abbreviations: C, Os capitatum. e, Os epitriquetrum. H, Os hamatum. h, Os hypotriquetrum. L, Os lunatum. l. s., Lateral intercarpal space. m. s., Medial intercarpal space. Tq, Os triquetrum.

Fig. 1. The 'medial (m. s.) and lateral (l. s.) intercarpal spaces'.

Fig. 2. The os epitriquetrum (e), dorsal aspect, after GRUBER (1883).

Fig. 3. After PFITZNER (1900) to show the os epitriquetrum (e) as the dorsomedial boundary of the 'medial intercarpal space'.

Fig. 4. The 'os hypotriquetrum' (h) in the 'medial intercarpal space', after SAUNDERS (1942).

Fig. 5. Os epitriquetrum, case I. Drawing from part of the roentgenogram (fig. 10).

Fig. 6. Os epitriquetrum, case II. Drawing from the lateral roentgenogram (fig. 11).

Fig. 7. Os epitriquetrum, case II. Drawing from part of the roentgenogram (fig. 12).

Fig. 8. Os lunatotriquetrum with distal sulcus. Drawing from part of a roentgenogram (fig. 13).

Fig. 9. Drawing of probable Os epitriquetrum in the 'medial intercarpal space' of a 24 mm C. R. human embryo.

GRUBER (1883) described the epitriquetrum as a three-sided pyramid with its base situated dorsally, and articulating with the triquetrum, lunate, and hamate (fig. 2). PFITZNER (1900) gave a similar description

and in a diagram of the accessory carpal ossicles the epitriquetrum is shown in this position, separated from the capitate, *i. e.*, on the medial side of, or slightly medial to, the medial intercarpal space (fig. 3). The ossicle featured by SAUNDERS (1942) was also a three-sided pyramid but with its base situated on the *palmar* aspect of the carpus, and articulating with the triquetrum, lunate, capitate, and hamate (fig. 4). The dorsal apex was related to a synovial tag projecting into the joint cavity from the deep surface of the dorsal carpal ligaments. The ossicle occurred bilaterally in a man of 70 years.

Very few cases of epitriquetrum have been recorded subsequent to the observations of GRUBER and PFITZNER. DWIGHT (1907) saw what he considered to be a doubtful (dorsal) case. GRUMBACH (1921) illustrated three possible instances: the first appears from the lateral roentgen film to be dorsal in position, the second occurred in a young subject, the third he interpreted as an incipient stage of lunate-triquetral synostosis. HEIMERZHEIM (1925), who referred to a case of LILIENFELD, also illustrated a possible instance, but with a history of trauma. The epitriquetrum was not found by BOGART in 1,452 individuals. FERGUSON (1933) illustrated a case in the left hand of a boy aged 15 years; it is not clear if it were dorsal. THEWS (1939) showed a case which appears from the lateral view to be dorsal in position. MARTI (1947) found a dorsal case in the right hand of a man aged 32 years.

Cases of Epitriquetrum

The present author, through the courtesy of Dr. JAMES E. LOFSTROM, was enabled to inspect 743 routine adult carpal roentgen films at the Detroit Memorial Hospital. Only 45 films (6 %) showed possible cases of accessory ossicles. Since a number of these are likely to have had a traumatic origin the incidence of accessory ossicles would be appreciably lower, and at the most, 12 instances (1.6 %) could be considered as free from suspicion. BOGART found 0.4 % in 1,452 individuals. The accessory tarsal ossicles, by contrast, have shown incidences varying from 25 to 75 %, depending on the writer.

Two films in the series are of present interest. In one an opaque area of approximately 0.5 mm diameter was observed in the site of the medial intercarpal space; the area was too small, however, to exclude satisfactorily the possibility of an artefact. In the second film (figs. 5 and 10) a larger area, assumed to be an epitriquetrum, was found on the medial side of the space; it was not possible to identify it on the lateral film.

A further instance of epitriquetrum was obtained through the kindness of Dr. J. L. A. GROUT, and Dr. THOMAS LODGE of the Royal Hospital, Sheffield, England (figs. 6, 7, 11, and 12). Two small adjacent os-

sicles are evident in the medial intercarpal space of an adult hand. No clinical details are available. The larger ossicle is seen on a lateral view to be dorsal in position and is typical of the epitriquetrum; the smaller nodule is at the distal ulnar angle of the lunate but cannot be distinguished with certainty in the lateral view.

Os Lunatotriquetrum

'Fusion', in the sense of a coherence of normally adjacent structures, has been found between most of the carpal (tarsal) and metacarpal (metatarsal) bones (O'RAHILLY, 1951, 1953). The anomaly is sometimes associated with hereditary symphalangia. Certain tarsal fusions are of importance in peroneal spastic flat foot and their mode of formation is therefore of considerable interest.

Fig. 10. Roentgenogram showing os epitriquetrum, case I. See fig. 5 for diagram.

Reports of isolated fusions *across* the medial intercarpal space have not been seen by the present writer. MEVES (1938), however, places the numeral '2' (to represent two recorded instances) in the space, and union across the space has been found in cases of mass fusion, *e. g.*, by L'HEUREUX (RUCKENSTEINER, 1931) and KEWESCH (1934).

The most frequent carpal fusion occurs between the lunate and triquetrum (os lunatotriquetrum) and was first observed by SOEMMERING (DUPAS and BADELON, 1932). The present writer found one case (0.13 %) in the 743 wrists referred to previously (figs. 8 and 13). LÖNNERBLAD (1935) encountered 3 cases in 2,100 carpal roentgen films (0.14 %) and ARENS (1950) observed 4 instances in 5,000 films (0.08 %). The incidence in negroid people, however, is greater, and SMITHAM, 1948 (see also MINNAAR, 1952) saw 40 cases in 680 West Africans (6 %). It is more frequent in males, and may be bilateral or unilateral.

A number of writers since PFITZNER have suggested that an accessory carpal or tarsal element may play a determining rôle in the development of carpal and tarsal fusions. Thus GRUMBACH interpreted the epitriquetrum as a preliminary stage in synostosis between the lunate and triquetral.

In a high proportion of cases of lunatotriquetral a groove distally

Fig. 11. Lateral view showing os epitriquetrum, case II. See fig. 6 for diagram.

Fig. 12. Roentgenogram showing os epitriquetrum, case II. See fig. 7 for diagram.

Fig. 13. Roentgenogram showing os lunatotriquetrum with distal sulcus. See fig. 8 for diagram.

between the bones is found (figs. 8 and 13). However, cases without a groove (see DUPAS and BADELON, 1932, for a description of dissected specimens) or with a groove proximally occur also. Similarly in instances of hamatocapitate coherence there may be a proximal or distal groove, or no groove (SMITHAM, 1948). The frequent occurrence of a lunatotriquetral sulcus precisely at the site of the accessory ossicle (epitriquetrum) suggests that this accessory element probably plays no part in the formation of the condition (unless the occurrence of an unossified element

unseen radiographically in these cases be postulated). In view of SAUNDERS' discovery of the hypotriquetrum, however, it would be of interest in future cases of lunatotriquetral to obtain more detailed information in order to establish whether or not the sulcus is constantly dorsal, palmar, or present throughout the dorsopalmar thickness of the carpus.

Teratogenesis

The present writer agrees with SAUNDERS (1942) that the accessory elements are "primarily an ontogenetic problem". The accessoria, "although they illustrate no phylogenetic principles, they do make evident the ontogenetic truth that prominent outgrowths of individual bones often tend to have a separate centre of development and, as DWIGHT says, they show 'the readiness of the elements of the tarsus to change their shape according to the circumstances'" (WOOD JONES, 1949).

THILENIUS (1894) found instances of the epitriquetrum in the hands of human embryos. A number of the accessory carpal elements have been found in serial sections of early human embryos by the present author, and in the medial intercarpal space of a 24 mm C. R. specimen a condensation (fig. 9) was observed which was attached to the distal ulnar angle of the lunate in dorsal sections and which seemed to become incorporated in the lunate in palmar sections.

The significance of these embryonic condensations is very obscure. It should be remembered that one and the same type of accessory bone need not have the same genesis in different individuals and the possibility of a postnatal or a pathologic origin in some instances should be kept in mind, *e. g.*, heterotopic ossification in synovial tags (SAUNDERS, 1942).

As has been mentioned earlier, the aetiologic relations, if any, between accessoria and coherences remain obscure. In carpal (tarsal) 'fusions' there is probably an absence of joint cavitation in the embryo — as has been maintained by LEBOUCQ (1890) and DWIGHT (1906) — and a chondrification of the articular 'interzone'. Anomalous embryonic fusions have been found in isolated instances (*e. g.*, by SOLGER, 1890; LEBOUCQ, 1890; DUKEN cited by POL in SCHWALBE, 1937) and the present writer has observed a continuity between the dorsal portions of the third metacarpal and trapezoid in a 170 mm C. R. human embryo. Certain fusions occur normally, *e. g.*, between the human scaphoid and os centrale, and anomalous continuities may be found in a number of regions, *e. g.* between cervical vertebrae or across the sacro-iliac joint. The embryonic fusions described by WHILLIS and others, however, are probably artefacts. It should be remembered that fusions may take place pathologically; HAGLUND described a woman who had unilateral tuberculous talonavicular and cuneonavicular arthritis at the age of 11 years and

yet showed a perfect talonavicular fusion at the age of 22 (LAPIDUS, 1932). Carpal and tarsal coherences have been observed in mice and rats after roentgen radiation (BEAN, 1929; WARKANY and SCHRAFFENBERGER, 1947), in experimentally split chick wing buds (WARREN, 1934), and in the nerveless joints of transplanted chick limb primordia (HAMBURGER and WAUGH, 1940).

Conclusions

1. A 'medial intercarpal space' is found commonly between the lunate, triquetral, capitate, and hamate bones (a 'lateral intercarpal space' occurs occasionally between the scaphoid, capitate, and trapezoid, and may have some relation to a centrale). Intercarpal intervals are occupied by intra-articular synovial folds which develop in the early embryo.

2. Intercarpal intervals are the sites of the occasional accessory carpal elements. The Os epitriquetrum, situated dorsally in the medial intercarpal space, has been found by about nine writers. Only one definite instance of a similar palmar element, here called 'Os hypotriquetrum', has been reported. Two further cases of Os epitriquetrum are illustrated here.

3. 'Fusions' have been recorded between most of the carpalia. The most frequent, Os lunatotriquetrum, is usually characterized by a distal sulcus at the site of the Os epitriquetrum, so that this element probably plays no rôle in the formation of the coherence.

4. The carpal accessoria are not excessively rare in early human embryos. An element in the medial intercarpal space, and attached to the lunate, has been found in a 24 mm C. R. embryo. At least some 'fusions' arise as an absence of joint cavitation in the embryo, and a transarticular chondrification. It is likely, however, that not all accessoria and 'fusions' have the same mode of development, and some cases may arise pathologically.

SUMMARY

A 'medial intercarpal space' is found commonly between the lunate, triquetral, capitate, and hamate bones and is occupied by intra-articular synovial folds. It is the site of a rare accessory carpal element (os epitriquetrum) two cases of which are described. The carpal accessoria are not excessively rare in early human embryos and an element in the medial intercarpal space, attached to the lunate, has been found in a 24 mm C. R. embryo.

A case of lunate-triquetral 'fusion' is also described but there seems to be no evidence that an accessory carpal is concerned in the formation of carpal 'fusions'.

ZUSAMMENFASSUNG

Ein „mittleres intercarpales Spatium" wird gewöhnlich zwischen den Handwurzelknochen Os lunatum, Os triquetrum, Os capitatum und Os hamatum gefunden; es ist durch intraartikuläre Synovialfalten ausgefüllt.

Es ist der Sitz eines seltenen carpalen Gebildes (Os epitriquetrum). 2 derartige Fälle werden beschrieben. Die akzessorischen Karpalknochen sind bei jungen menschlichen Embryos nicht ausserordentlich selten und ein derartiges Gebilde wurde im mittleren intercarpalen Spatium, verbunden mit dem Os lunatum, bei einem Embryo von 24 mm Schädel-Rumpflänge beobachtet.

Es wird auch ein Fall mit einer Fusion zwischen Os lunatum und Os triquetrum beschrieben; hier scheint jedoch kein Anhalt dafür zu bestehen, dass ein akzessorischer Karpalknochen an der Bildung der carpalen Fusion teilhaftig ist.

RÉSUMÉ

On trouve communément un «espace intercarpien interne» entre le semi-lunaire, le pyramidal, le grand os et l'os crochu, occupé par des replis synoviaux intra-articulaires. Il est parfois le siège d'un os carpien accessoire (os epitriquetrum), dont l'auteur présente deux cas. Les os carpiens accessoires ne sont pas très rares chez les jeunes embryons humains; on en a trouvé un, dans l'espace intercarpien interne, attaché au semi-lunaire, chez un embryon de 24 mm.

L'auteur décrit aussi un cas de «fusion» pyramido-lunaire, mais il ne semble pas y avoir de preuves qu'un os carpien accessoire intervient dans la formation des «fusions» carpiennes.

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FROM THE ROENTGEN DEPARTMENT (DIRECTOR: PROFESSOR K. LINDBLOM), KAROLINSKA SJUKHUSET, STOCKHOLM, SWEDEN

A MAGNIFYING VIEWER FOR PHOTOFLUOROGRAPHIC FILMS

by

Ove Mattsson

A satisfactory interpretation of mass miniature radiographs requires a magnifying arrangement. Both the study of smaller details and the reading of the patient's name, which is reproduced on the film, is otherwise difficult. There are at present no simple and effective viewers for miniature radiographs on the market.

The ability of the eye to discern details is optimal when irrelevant fields of vision are shaded off. The author has previously pointed out this fact in connection with the aspects of the interpretation of detail and contrast in radiographs (1952). The important effect of scattered light on the eye, when directed towards a source of light (viewing box), will be reduced to a considerable extent, to the benefit of the correct interpretation of especially dense details with a high degree of blackening. The masking of unnecessary surrounding light is also important for the examination of mass miniature radiographs. These films, indeed, have only one emulsion layer and thus possess a lower maximal blackening than double-coated roentgen films, but on the other hand the detail contrast must necessarily be lower than in the latter. Mass radiographs are always examined in such a manner that the glossy film surface is towards the observer. The reflection from this surface is irritating and may also be avoided by masking.

The simple magnifying glasses often used for the study of mass radiographs are ordinarily monocular, but if they are of large diameter it is possible to use them for binocular observation. Hand-lenses collect dust, which is a nuisance. The eyes work most comfortably with an individual glass in a correct position for each eye. For an optimal function of the lenses, shading off of unnecessary light is also essential: reflection from

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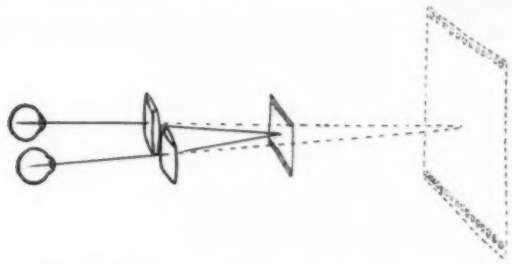

Fig. 1. The path of rays in the optical system; the broken line corresponds to the virtual image.

Fig. 2. The magnifying viewer in use.

the lens surfaces will be reduced and dust particles will not be so disturbing.

A device for the examination and magnification of miniature radiographs and which fulfils the criteria mentioned above has been constructed by the author on the same principles as the viewer for ordinary radiographs earlier described (1952). It consists of a hood in the shape of a truncated pyramid, one end forming a light-proof seal around the eyes, the other having an opening corresponding to the film size. (The viewer

is made for 80 mm film.) Between the eyes and the film window are two lenses in such a position and with such a refraction that the eyes can study the film comfortably when it is placed close to the square opening. Many tests have been made in order to arrive at the correct type of lense. Suitable lenses for an apparatus of 20 cm length and a 13 cm film—lens-distance have a refractive power of 3.5 dioptres. At the same time they each have a prismatic deviation of 5°. The latter factor reduces the need of convergence of the eyes and gives more comfortable viewing; the positive lenses make the eye see the image as though it were at a greater distance.

The function of the optical system is shown in Fig. 1. The appearance of the viewer is illustrated in Fig. 2. It is not unlike the viewer without lenses earlier described by the author, but is shorter and more compact. The inside of the apparatus is finished in matt black which eliminates reflection. The outside is covered with cloth.

The viewer is particularly suited for use in combination with a desk type viewing lantern for mass miniature radiographs equipped with a fluorescent tube. The illuminated opal glass plate is mounted at a suitable angle (Fig. 2). The device may of course also be used for viewing details in magnification in ordinary radiographs. In this respect it has served very well in the examination of angiographs, for example for studying the small vessels of the female pelvis.

The viewer is manufactured by Georg Schönander AB., Stockholm.

SUMMARY

A magnifying viewer is described in which the irrelevant fields of vision are shaded off, an improved interpretation of details being thus obtained.

ZUSAMMENFASSUNG

Eine vergrössernde Betrachtungsapparatur wird beschrieben, bei der die irrelevanten Blickfelder abgeschirmt sind und auf diese Weise eine verbesserte Deutung der Einzelheiten möglich wird.

RÉSUMÉ

L'auteur décrit un négatoscope grossissant qui permet, en obscurcissant les parties inutiles du champ de vision, d'obtenir une meilleure interprétation des détails.

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FROM THE RADIOTHERAPY DEPARTMENT (CHIEF RADIOTHERAPIST: DR. R. C. TUDWAY), BRISTOL ROYAL HOSPITAL, BRISTOL, ENGLAND

THE USE OF RADIO-ACTIVE ISOTOPES IN AN APPLICATOR FOR THE TREATMENT OF CARCINOMA OF THE CERVIX UTERI

by

Robert C. Tudway

Many people have sought to improve the dose distribution from radium used to treat carcinoma of the cervix uteri. Radium has usually been used in ordinary tubes with little more than the platinum wall of the tube in the way of screening, and inserted in simple applicators. Such techniques differ only in detail so far as the arrangement of the sources is concerned (we are not concerned here with the question of timing of treatments). Examples are the Paris, Stockholm or Manchester methods. In all these, the essential arrangement is that of two radium sources, one in each lateral fornix and a central tube in the uterus.

An object in using radium to treat carcinoma of the cervix, is to dose with gamma rays as much as possible of the area of probable spread, extending the treatment as far as possible towards the pelvic walls as well as taking in the whole of the uterus, vaginal vault and neighbouring tissues.

The uterus, vaginal vault and parametrium, as far laterally as 3 cms from the mid-line, are well covered by the established techniques when adequately applied. A difficulty is to treat the parametrium beyond the 3 cm mark, and especially the region at the junction of parametrium and pelvic wall.

Diagram 1 shows the points of special interest. Points 'A' as defined by the Manchester school, are 2 cms above the lateral fornices of the vagina, and 2 cms from the mid-line. They lie in the parametrium and are important in that overdosage here (over about 8,000 roentgens) is liable to produce undesirable reactions. Points 'B' lie on the same

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level, but 5 cms from the mid-line. Points 'C' lie 7 cms out at the bony wall of the pelvis. No treatment is called for further out than 'C' and, up to now it has hardly been possible to give adequate dosage even as far out as 'B'. If a real attempt is to be made to treat spread of growth to the pelvic wall, then adequate dosage must be given to point 'B' and beyond. Although a dose up to 8,000 r (roentgens) at 'A' is desirable, this dose even if attainable, would be excessive over the larger area extending from one pelvic wall to the other. At the same time care must be taken not to exceed 6,000 r at the bladder or recto-vaginal septum.

It has already been pointed out that, to improve the dose attained at the lateral pelvic wall compared with the tissues near the uterus (*e. g.* 5—7 cms and 2 cm from the mid-line), the vaginal radium should be placed in the mid-line, that is away from the fornices and the amount of radium increased. This definitely increases the dose at the pelvic wall compared with the para-cervical regions and the vaginal vault itself. This cannot be done by the simple arrangement, however, because an increased amount of radium is brought nearer the bladder and rectum, and will cause undesirable reactions. The next step then, is to provide deliberate shielding between the radium and the bladder and rectum by means of gold or platinum, and to make this intravaginal shield of a complicated form which will also somewhat reduce the dose in the para-cervical region (point A. Diagram 1) in an effort to approach by means of intracavity radium an equal dosage of all tissue involved by growth.

These points have been studied in great detail in 1943 by NEARY who in 1947 has produced a design for such an applicator. He also at first concentrated the intra-uterine radium at the fundus of the uterus, but has had to abandon this point owing to excess dose effects there.

NEARY's design gives the greatest possible dose to the pelvic wall which can be attained from radium in the vagina.

BLOMFIELD has designed (1947), and is using at Sheffield, another but less extreme example of the same principles which provides a greater margin of safety at the points which tend to be over-dosed, but at the same time does not provide such a good dosage at the pelvic wall.

A severe limiting factor preventing a better dose distribution by these methods is the great penetrating power of the gamma rays from radium which pass too easily through the screening metal, and if enough radium is used to give sufficient dose to the pelvic wall, then other parts will still be overdosed.

It will be realised that the use of radioactive substances of less penetrating power than radium would be an advantage. For instance, certain radioactive isotopes may be used, as NEARY himself mentioned. These

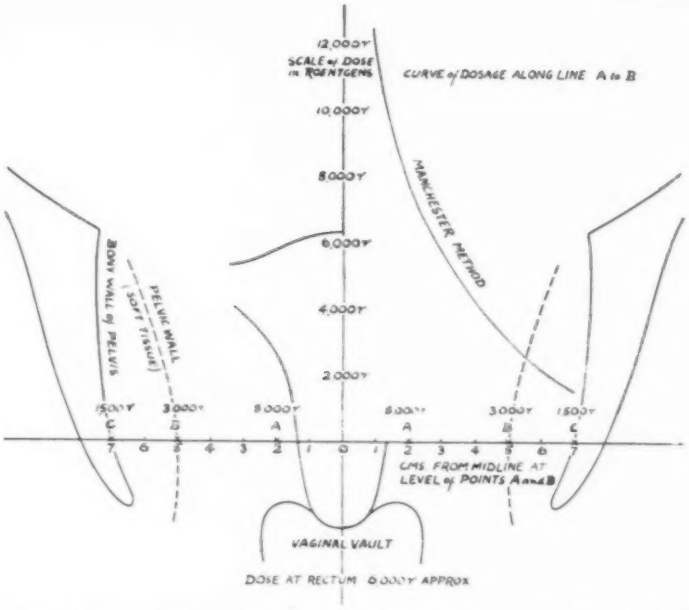

Diagram 1. Dosage from Manchester technique along a line from internal O. S. (approx.) to the pelvic wall.

have now become available, and the use of radioactive iridium will be suggested here as a first venture, though other isotopes may also be used and substituted for the iridium later.

Radioactive iridium gives out gamma rays of much lower energy than radium. These can be shielded with very much smaller amounts of metal. In fact it is easily possible to overdo the shielding of the recto-vaginal septum and leave an untreated area in the vaginal vault. It is possible to produce a nearly equal dosage near the cervix and at the pelvic wall, and to do that without increasing the intra-uterine source of radiation to any undesirable value.

A general arrangement of iridium sources and shielding for such radioactive iridium applicators has been worked out in the Radiotherapy Department at Bristol.

This general scheme is given below with comparisons with other techniques, and the dosage to be expected at various anatomical points. The type of applicator used is a modification of a perspex applicator developed and used by BLOMFIELD at Sheffield, details of which have not yet been published.

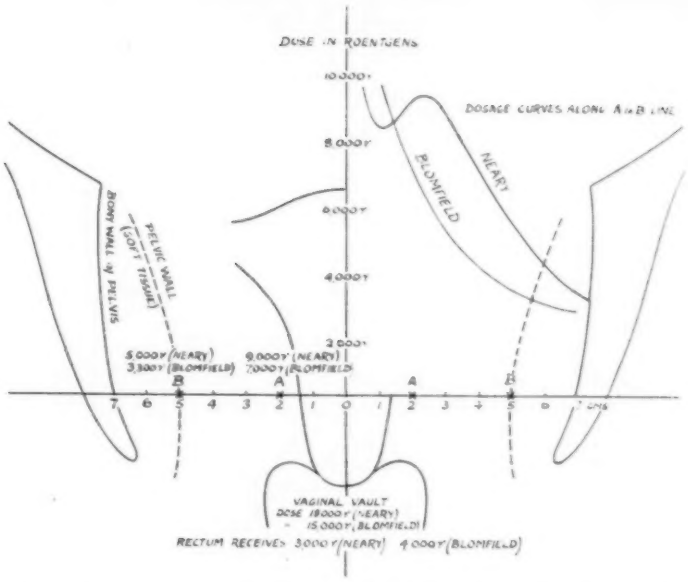

Diagram 2. Dosage from Neary and Blomfield special applicators.

The detailed dimensions of the sources, shielding, and applicators used with the iridium, will be described elsewhere.

As mentioned above, most of the techniques which have been used till now in this country are variations of either the 'Paris' or the 'Stockholm' methods. I propose to take as an illustration of them the 'Manchester' method, because it provides a distribution of radiation which is similar in form to the others but better than many in both dosage and clinical results. It is a refinement of the 'Paris' technique. Diagram 1 shows the dosages attained at different points near the uterus by this orthodox method. Maximum dosage at point 'A' is of the order of 8,000 r (roentgens). It will be seen that the recto-vaginal septum also is given the maximum permissible dose. Unfortunately, the lateral pelvic wall and the lymph nodes in that region cannot under the most favourable conditions of a large distensible vagina exceed 3,200 r 5 cms laterally and about 2,200 r at 6 cms. A small vagina will produce dosages about 800 r less. The curve included in the right-hand side of the diagram shows this rapid fall off of dose towards the pelvic wall. At the same time this method is excellently contrived to dose adequately, but not excessively, all tissues within its reach.

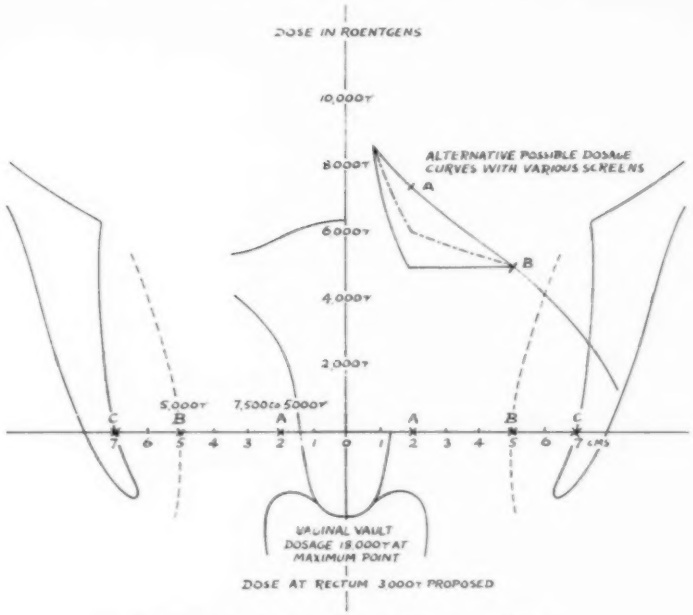

Diagram 3. Dosage from iridium applicator.

Results obtained by NEARY are shown in Diagram 2. When NEARY gives 9,000 r near point 'A' 5,000 r are given at the 5 cm point and 4,000 r at 6 cms laterally, while only 3,000 r are given to the rectum. This for about 18,000 r given to the vaginal fornices. The latter figure is not excessive owing to the very great tolerance of these parts to radiation, but the 9,000 r given near the uterus in the parametrium is on the high side for this much more sensitive part and may give rise to late reactions. It is difficult to do better with radium.

This diagram also gives the dosages attained by BLOMFIELD's 'bomb' type applicator. Here a central radium source is screened with gold or platinum but the design is not so extreme as in the previous example. Dosage at the pelvic wall is better than that of the Manchester and other more orthodox types, as would be expected, being of the order of 3,000—3,500 r at point 'B' while it avoids any points of over-high dosage.

Diagram 3 shows the dose distribution to be expected from the iridium applicator. The central uterine tube to be used with it will be of similar strength to those in current use in the orthodox techniques, *i. e.*, equivalent to about 4,000 milligram hours of radium.

The iridium source can be centrally placed in the vagina so allowing,

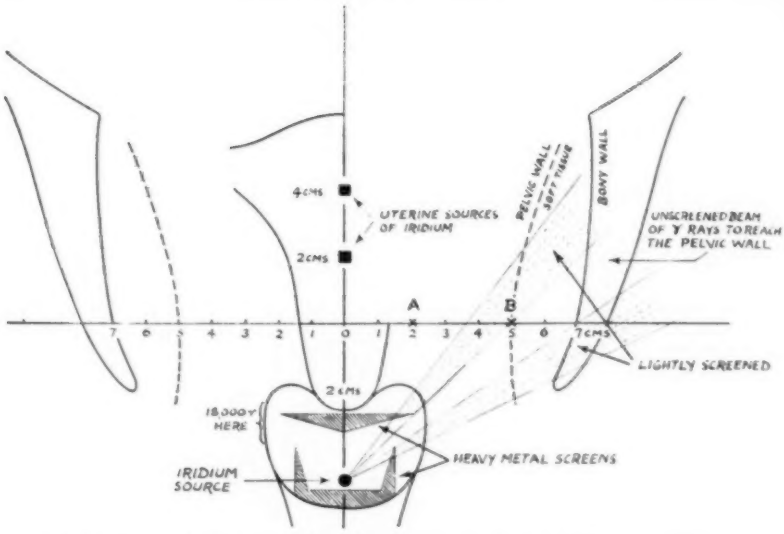

Diagram 4. Diagram of principle of arrangement of iridium applicator.

with the contribution from the uterine source, a dose at the 5 cm point on the pelvic wall of 5,000 r. Screenage within the applicator will at the same time limit the dose near the uterus at point 'A' to any chosen value between 7,500 r and 5,000 r according to the degree of screenage used, and will allow over-high dosage to be avoided here while it gives a very similar dosage to NEARY's applicator at points 'B' and 'C' which is a fairly adequate dose. Overdosage at the bladder and rectum is avoided.

This screenage could theoretically be made to produce either a level dosage or a quite even drop in dose between points 'A' and 'B'; if a slightly uneven curve be accepted then the shape of the screen is simpler.

This even drop in dose as one moves laterally, the relative equality of the doses at 'A' and 'B', and the absence of excessive dose at 'A' will allow of easy application of a small amount of supplementary deep roentgen rays from the side of the pelvis if desired. These figures are for a maximum dose in the lateral vaginal fornix of about 19,000 r for a 5 cm wide applicator. When smaller applicators are used then the dose at the pelvic wall will be reduced unless a small area of still higher dose is accepted in the vaginal vault. This area of high dose may still, however, be less intensively irradiated than by a Stockholm box.

Here it is probably not desirable to strain the capacity of the intravaginal source to the limit, but to be ready to give a small amount of

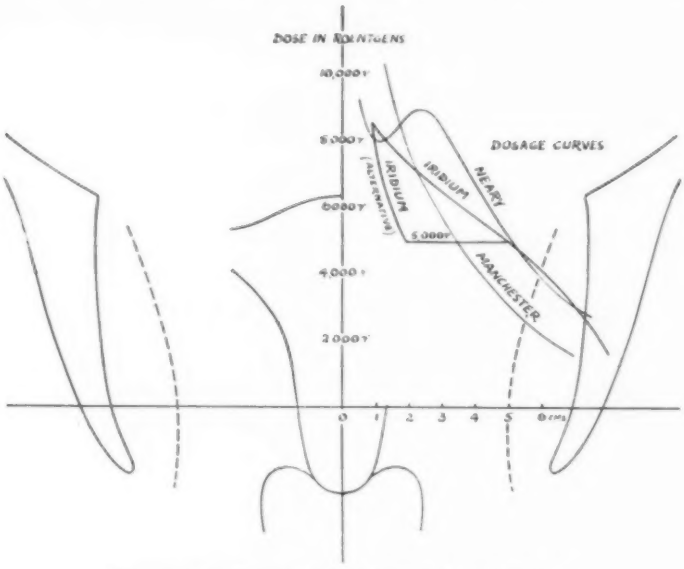

Diagram 5. Comparison between dosage curves.

external radiation as well. In fact this external radiation can become an important, if small, part of the whole scheme of dosage.

It is possible to have two alternative types of iridium applicator; the first for use in the later stage II, and stage III cases (here the dose at point 'A' is kept below the maximum and is designed to be used with some additional deep roentgen-rays; the dose at the pelvic wall is raised to the level of about 6,000 r by adding an additional 1,500 r or so by deep roentgen-rays, while not overdosing point 'A'). The second type is for use in earlier cases, and the full 7,500 r is given to point 'A' but no additional deep roentgen-rays. The desirability of not treating the pelvic wall even in early cases is, however, debatable.

Diagram 4 shows the position of the iridium and the places where screening with heavy metal will be needed, and the approximate form of the screens. The dosage curves obtained by the various methods are superimposed in diagram 5.

Conclusion

The iridium applicator is designed to improve the dosage of radiation near the pelvic wall when treating carcinoma of the cervix uteri by means of an intra-vaginal applicator, and to do this with less risk

than previously of overdosage at other points. The applicator is designed to be lighter than comparable types of similar performance for use with radium.

The timing of the dosage may be either on the Stockholm principle of two or three treatments, each of one day's duration, spread over a period of up to three or four weeks; or on the Paris principle of five to eight day's treatment within a period of under ten days. In the latter case, about half the amount of iridium compared with the former would be used.

SUMMARY

A comparison is made of the dosage distribution obtainable with several radium techniques for treating carcinoma of the cervix uteri. The limitations of radium which prevent a useful dosage being obtained at the pelvic wall are discussed.

If gamma-rays of much lower penetration, *e. g.* from radioactive iridium, are used the parts which tend to be overtreated may be more easily shielded and a useful dose allowed to reach the pelvic wall. The approximate form of an applicator for such a purpose is given, and the dosage distribution to be expected from this is shown in the diagrams.

ZUSAMMENFASSUNG

Die Dosisverteilung, die mit verschiedenen Radiumbehandlungstechniken bei der Behandlung der Carcinoma cervicis uteri erreicht werden kann, wird einem Vergleich unterzogen. Die Strahlungsbedingungen des Radiums, welche verhindern, dass die Beckenwand eine nützliche Dosis erhält, werden diskutiert.

Wenn Gammastrahlen von viel geringerem Penetrationsvermögen, z. B. von radioaktivem Iridium, benutz werden, können die Körperabschnitte, welche einer eventuellen Überdosierung ausgesetzt sind, leichter geschützt werden und die Beckenwände eine nützliche Dosis erhalten. Die approximative Form eines Applikators für derartige Zwecke wird beschrieben und die zu erwartende Dosisverteilung wird in Diagrammen wiedergegeben.

RÉSUMÉ

L'auteur compare la répartition des doses obtenue avec différentes techniques de curiethérapie dans le traitement du cancer du col de l'utérus. Il étudie les limitations de l'emploi du radium qui empêchent d'obtenir une dose utile à la paroi pelvienne.

Si on emploie des rayons gamma beaucoup moins pénétrants, par exemple ceux de l'iridium radioactif, il est plus facile de protéger les parties qui risquent d'être surdosées et d'obtenir une dose utile à la paroi pelvienne. L'auteur indique la forme approximative d'un tel applicateur et donne des graphiques montrant la répartition des doses qu'on peut en attendre.

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IODINE-CONCENTRATING THYROID CARCINOMAS

A report of three cases

by

A. Egmark, L.-G. Larsson, Å. Liljestrand and *Inger Ragnhult*

Ten years ago the first case of storage of radioactive iodine in a metastasis from a thyroid carcinoma was reported (6). This observation was followed by extensive studies with radioactive iodine, and investigations by *in vivo* measurements and radioautography revealed that these tumours not infrequently stored iodine (1—20). As would be expected it was mainly the well-differentiated alveolar and follicular adenocarcinomas that concentrated iodine. Pure papillary carcinomas and poorly differentiated tumours usually did not store iodine.

This discovery was soon followed by therapeutic trials. During the ten year period which has elapsed a considerable number of metastasizing thyroid carcinomas have been treated by radioiodine, and rather important information has been obtained about the possibilities and limitations of this form of treatment. Only a few thyroid carcinomas possess the property of taking up radioiodine in sufficient quantity to justify therapeutic measures. In addition, the radioiodine is usually irregularly distributed in the metastases. Total removal or destruction of the normal thyroid tissue increases the uptake of radioiodine in the tumour tissue and is now generally accepted as the first step to be taken when a thyroid carcinoma is to be treated by radioiodine (12, 14, 17, 18, 19); 'radiologic thyroidectomy' may be performed by an initial large dose of radioiodine. Internal medication with thyrotropic hormone and thiouracil may also increase the iodine-concentrating capacity of the tumours (12, 17, 19).

The radioiodine treatment of generalized thyroid carcinomas has in some respects been disappointing. Several cases have been treated

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without benefit and in other cases only slight or partial regression of the tumours without practical importance has occurred. In a few cases, however, very remarkable palliative results have been reported. Serial tracer investigations with radioiodine of cases with metastatic, well-differentiated thyroid tumours constitute the only method of finding those suitable for radioiodine treatment. Since 1950 several cases have been examined at the Radioisotope Laboratory of Radiumhemmet, and so far only three have been found with an uptake of I^{131} large enough to justify therapeutic trials. These cases are now reported.

Case 1. J. G. (Medical Clinic), male, aged 56, had for several years suffered from severe arterial hypertension; in October 1948 he had a cerebral haemorrhage with aphasia and right-sided hemiparalysis. A chest radiogram at that time revealed a large intrathoracic goitre and a small round density in the right lung. In March 1950 a rapidly increasing tumour over the right clavicle was noted and an examination in May 1950 revealed a subcutaneous mass, large as an orange, protruding from this bone. Radiograms showed extensive osteolytic metastases in the right clavicle, the left scapula and the sacrum. The intrathoracic goitre had increased considerably, and the round density in the right lung, now considered a metastasis from a malignant goitre, had also increased. He had also two subcutaneous soft tissue metastases, one beneath the left clavicle and the other in the left upper arm. Aspiration biopsy of the tumour in the right clavicle was performed. The microscopic investigation showed alveolar thyroid adenocarcinoma with some papillary structures but without colloid-containing follicles (Fig. 1).

From May 1950 until March 1951 he received a total of 318 mC I^{131} by mouth (Table 1). An initial dose of 90 mC was given, principally to destroy the normal thyroid tissue.

Table 1. *Case 1.*

Date	Oral dose of I^{131}	Urinary excretion of I^{131} 0—24 hours	24—48 hours
May 3. 1950	90 mC		
June 21.	1 mC		
Sept. 27.	1 mC	45 %	3 %
Oct. 27.	7.6 mC	36 %	13 %
Nov. 8.	82 mC	50 %	18 %
Dec. 6.	10 mC	48 %	19 %
Dec. 13.	98 mC	42 %	20 %
March. 6. 1951.	10 mC	40 %	18 %
March 19.	100 mC	47 %	20 %

After the subsequent doses, *in vivo* measurements were performed with a G.-M. counter and the urinary excretion of I^{131} was also measured. Uptake of radioiodine was found in the primary tumour and in all the metastases excepting those in the sacrum, where no significant uptake could be demonstrated. The only visible therapeutic effect was a temporary slight regression of the soft tissue part of the metastases in the region of the right clavicle after the first therapeutic doses. Repeated radiograms revealed further pulmonary metastases and the primary tumour as well as the bone metastases increased in size. A successive depression of the blood picture was noted during the time of observation. In March and April 1951, a significant trombocytopenia and an increased bleeding tendency developed.

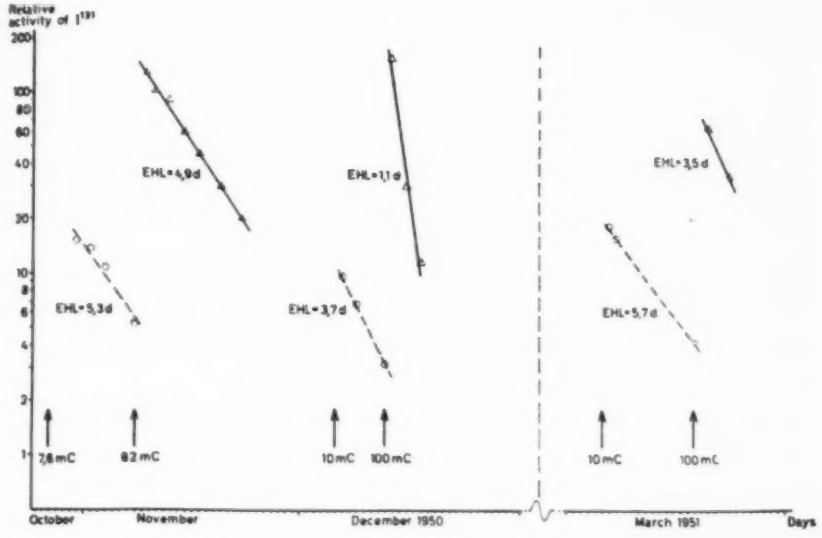

Diagram 1. Case 1. The disappearance rate of I^{131} in a mediastinal malignant goitre. EHL = effective half-life of I^{131}.

The patient died in August 1951 from a cerebral haemorrhage. A complete autopsy was refused. The mediastinal mass as well as the metastases in the right clavicle, infraclavicular soft tissue and a part of those in the sacrum were excised for microscopic examination. No normal thyroid tissue could be found macroscopically or microscopically. The tumours represented solid, alveolar and papillary thyroid adenocarcinoma with predominance of the alveolar structures. Quite large areas of necrotic tumour tissue were found in all the growths.

Certain details of the *in vivo* γ-measurements performed were of special interest. After the I^{131} doses given from October 1950 until March 1951, serial measurements with a collimated G.-M. tube were performed over the mediastinal mass and certain of the iodine-concentrating metastases in order to study the disappearance rate of I^{131} in the tumour tissue. At that time probably all normal thyroid tissue had been destroyed by the initial massive dose of I^{131} given in May 1950. Diagram 1 shows measurements over the mediastinal tumour and similar results were obtained from the iodine-concentrating metastases. The following observations were made:

1. The effective half-life of I^{131} in the tumours was considerably shorter than in a normal thyroid. This is in agreement with certain other observations (1, 9).

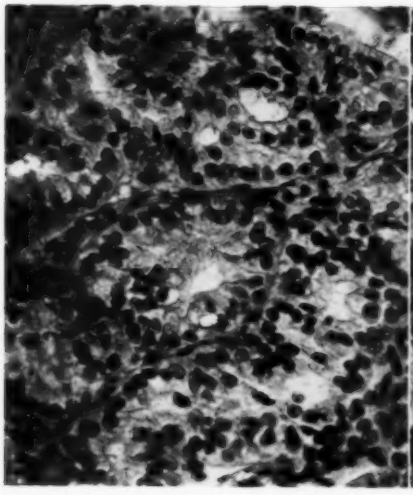

Fig. 1. Case 1. Bone metastases in right clavicle. Well-differentiated thyroid adenocarcinoma. No colloid follicles. × 300.

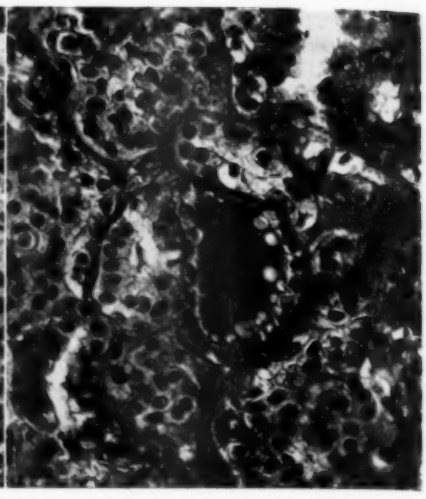

Fig. 2. Case 2. Lymph node metastases from the neck. Well-differentiated thyroid adenocarcinoma. A few colloid follicles. × 300.

2. During the period October—December 1950 when the patient received four doses of I^{131} with rather short intervals, the effective half-life of I^{131} in the tumours successively decreased. This seems to indicate that the irradiation-damaged tumour tissue had less capacity to retain the collected radioiodine. Three months later when I^{131} was again given, the effective half-life had increased to the initial values.

3. On three occasions the patient received a 'moderate' dose of I^{131} (about 10 mC) followed in 1—2 weeks by a 'massive' dose (about 100 mC). Each time the effective half-life of I^{131} after the 'massive' dose was shorter than after the 'moderate' one. Recently published investigations give what may be a probable explanation of this observation (16). After massive doses of I^{131} an abnormal protein-bound fraction of I^{131} was found in the blood serum, probably thyroglobulin released from the thyroid or from functioning metastases during the destruction of the tissue evoked by the heavy irradiation. The appearance of this abnormal material in the serum corresponded with a rapid decrease of I^{131} in the thyroid (16).

Case 2. L. E. (Radiumhemmet), female, aged 14. Menarche in June 1950. Since the age of 10, she had observed nodules growing on the right side of the neck and a year later on the left side as well. In December 1950, microscopic examination of a lymph

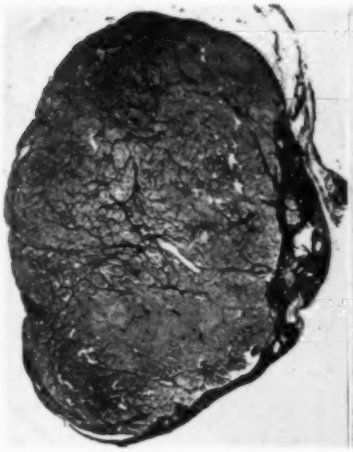

Fig. 3. Case 2. Lymph node metastases from the neck (March 1951).

Fig. 4. Case 2. Contact radioautogram of the same section as in Fig. 3, demonstrating a massive uptake of I^{131}.

node from the right side of the neck revealed thyroid carcinoma, predominantly alveolar with a few colloid follicles. At that time she had enormously large lymph node metastases on both sides of the neck. On the 20th Dec. 1950, an explorative operation on the left side was performed. A very large mass of lymph node metastases was found and the primary tumour which infiltrated the whole thyroid was fixed to the surrounding tissues making radical operation impossible. Some of the lymph node metastases and the greater part of the left thyroid lobe were removed. Microscopic examination revealed a malignant tumour of the same type as before (Fig. 2). Between the 11th Jan. and 16th Feb. 1951, the patient received teleradium treatment of 4,000 r on each of four fields on the right side and 3,500 r on four fields on the left side of the neck. A tracer test with I^{131} gave evidence of a high uptake by the metastases. Treatment with radioiodine was not tried at that time however, so as not to confuse the effect with that of the external irradiation. The tumour was rather radiosensitive and rapidly decreased in size, on the right side, to impalpability while on the left, remnants remained palpable. From February until March 1951 the lymph node metastases on the left side of the neck increased in size, and there were now several metastases up to the size of a plum palpable. *In vivo* measurements still revealed an uptake of I^{131} in the metastases and after a dose of 10 mC I^{131} one of the nodes was removed for radioautography. Microscopic examination revealed a tumour of the same type as previously (Fig. 3) without demonstrable irradiation changes. The radioautographs demonstrated a massive uptake of I^{131} (Fig. 4). From the 4th April until the 6th June 1951, a total of 228 mC I^{131} was given by mouth (Table 2). During and after the treatment the lymph node metastases decreased in size. On the 12th June 1951, one of the smaller metastases was removed for microscopic investigation. The structure was quite different from all the lymph node metastases previously removed as well as from the primary tumour (Figs. 5 & 6). Small parts of the lymph node contained solid, alveolar and papillary adenocarcinoma of the same type as previously. The greater part

Fig. 5. Case 2. Lymph node metastases from the neck (June 1951). Large areas with irregular follicle-like spaces with blood cells and degenerating tumour cells are now seen. Low magnitude.

Fig. 6. Case 2. Detail of Fig. 5. × 160.

of the lymph node, however, was built up of large follicle-like lumina containing red blood cells and pale vacuolized cells probably representing degenerating tumour cells. Between the lumina were areas dominated by large pale cells with pycnotic nuclei, probably damaged tumour cells (Fig. 6). In our opinion these changes must be regarded as an irradiation effect.

Table 2. *Case 2.*

Date	Oral dose of I^{131}	Urinary excretion of I^{131} 0—24 hours	24—48 hours
Jan. 16. 1951	1 mC	49 %	8 %
Jan. 30.	0.25 mC	51 %	
April 26.	1 mC	38 %	10 %
April 30.	10 mC	38 %	26 %
May 17.	76 mC	57 %	17 %
May 25.	73 mC	77 %	10 %
June 6.	68 mC	55 %	2 %
Aug. 31.	0.5 mC	43 %	8 %
Sept. 12.	100 mC	76 %	11 %
Jan. 10. 1952	0.5 mC		

On the 16th June 1951, the patient still had palpable metastases in the left upper part of the neck, as large as a hazel nut. On further examination in September 1951 these metastases had increased in size and measured about 40 × 25 mm. As a tracer test still demonstrated an uptake in the metastases, the patient received a further dose of 100 mC I^{131} by mouth. The metastases then successively decreased. In January 1952 they were the size of a cherry and by the middle of March, no remnant could be found. There were rather advanced fibrotic irradiation changes in the neck which made palpation of details difficult. The patient was, however, clinically free from signs one year after the last radioiodine treatment. After a new tracer dose in Jan. 1952, no uptake of I^{131} was found in the neck.

During treatment a myxoedema appeared and since June 1951 she required substitution therapy. No significant changes of the red and white blood picture or of the trombocytes was observed during or after the treatment. Menstruation is still normal. No evidence of distant metastases have been found on repeated roentgen examinations of the spinal column, pelvis and lungs.

Case 3. H. B. (Radiumhemmet), female, aged 66, was first operated on in 1933 for goitre, when right-sided hemithyroidectomy was performed. The clinical and the microscopic diagnosis was adenomatous colloid goitre. In March 1943, she observed a tumour growing on the left shoulder-blade. Roentgen examination in August 1944 revealed much bone destruction in the left scapula; on the 18th Oct. 1944 resection of the scapula was performed. The microscopic examination revealed metastases from a 'malignant thyroid adenoma'. The tumour was predominantly of the alveolar and follicular type, but small portions of it were solid. Total thyroidectomy was performed on the 2nd Nov. 1944. The microscopic examination showed an adenomatous goitre with evidence of probable malignancy. Radiograms of the bones and lungs disclosed no further

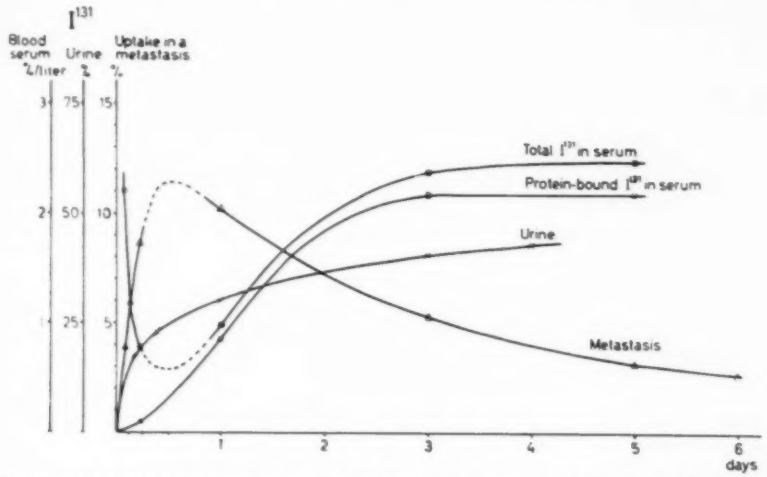

Diagram 2. Case 3. Studies on the uptake of I^{131} by bone metastases in the lumbar spine as well as on plasma concentration and urinary excretion of I^{131}. The disappearance rate of I^{131} is more rapid than in normal thyroid tissue and the plasma concentration curve has the same type as in hyperthyroidism.

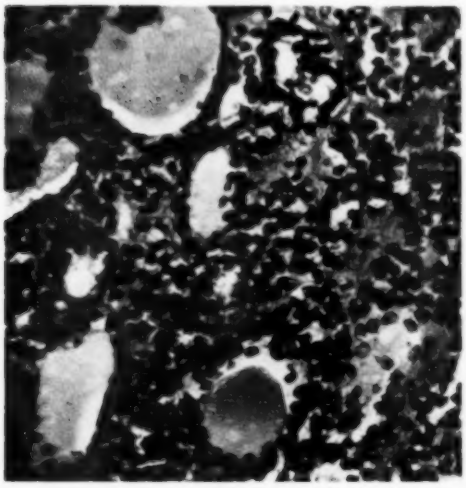

Fig. 7. Case 3. Recurrent thyroid tumour. Well-differentiated thyroid adenocarcinoma. Numerous colloid follicles. × 300.

metastases. In January 1945, a recurrence of the primary tumour on the right side of the neck was observed. And on the 2nd Feb. 1945 a further operation revealed a malignant tumour of the same type as before (Fig. 7). Since that time there have been no signs of the primary tumour.

In April 1950, radiograms of the skeleton disclosed destruction of the 8th and 9th thoracic bodies as well as suspected involvement of the 2nd and 3rd lumbar vertebrae. The former lesions were treated by roentgen, a total of 2,500 r being administered. Further roentgenograms on the 16th Oct. 1951 demonstrated increased destruction on the right side of L. 2 and L. 3 and a new lesion on the left side of Th. 4 and Th. 5. A tracer test with I^{131} showed a strong uptake by the metastases in L. 2 and L. 3 (approximately 10 per cent of the given dose) and a smaller uptake by the metastases in Th. 4 and Th. 5 (1—2 per cent). No uptake could be established in the neck or in the roentgen-treated metastases in Th. 8 and Th. 9. As the patient had pain in the middle part of the back she again received roentgen treatment to Th. 8 and Th. 9, the total dose being 1,500 r. The metastases in Th. 4 and Th. 5 and those in L. 2 and L. 3 were not included in the roentgen field.

On the 7th Dec. 1951, 200 mC I^{131} was given by mouth. The uptake by the metastases was about the same as after the tracer dose. Heavy uptake was also noted in an area in the right side of the pelvis and where radiograms had suggested the presence of metastases. A new tracer test in April 1952 still demonstrated an uptake by the metastases in the lumbar spine and pelvis and shortly afterwards a further 100 mC I^{131} was administered by mouth. A significant uptake was still demonstrable by these metastases after a further tracer dose in June 1952 and 100 mC I^{131} was then again given; the relative uptake was now only about one fifth of the initial one. After a tracer dose on the 30th Oct. 1952, no significant uptake was found in the metastases.

The patient previously had pain, probably caused by the metastases in the spine and pelvis; this diminished after the treatment. Repeated radiograms of the spine and pelvis revealed a picture essentially unchanged. A radiogram of the skull demonstrated

multiple small areas of destruction which increased slightly during the time of observation. The patient had for several years suffered from anaemia which had required treatment by means of blood transfusions. No significant change in the blood picture, with the exception of a slight temporary trombocytopenia, could be demonstrated after the I^{131} treatment. In January the patient suffered from multiple echymoses on the lower legs and which later disappeared. She was still in a good general condition on the last control in October 1952.

In this case strong evidence was gained about the hormon-producing capacity of the metastases. After total thyroidectomy in 1944, there were signs of hypothyreosis and a low basal metabolism. The patient received no substitution therapy. Despite this fact she gave evidence of hormonal balance during the years 1946—1949 with no symptoms of myxoedema. From 1950 she exhibited slight signs of hyperthyroidism. She was a little nervous and restless, had flushing of the face and tremor of the fingers. The basal metabolism showed increasing values up to + 54 per cent. Investigation with I^{131} revealed no uptake at all in the thyroid region. In spite of this, the plasma concentration curve of I^{131} was of the same type as that found in thyreotoxicosis. The plasma concentration rapidly decreased to less than 1 per cent/liter during the first six hours and after the first day increasing concentrations were noted with values above 2 per cent/liter; most of the radioiodine was found in the protein-bound fraction, probably as radiothyroxin (Diagram 2).

Discussion

A pronounced therapeutic effect was noted in only one of the three cases reported. This patient (Case 2) was a young girl with large lymph node metastases in the neck; in this case no activity of the tumour was observed clinically one year after the last treatment. In Cases 1 and 3, relief of pain but no objective regression of the bone metastases was obtained.

As regards the complications of the treatment a significant if not very serious trombocytopenia occurred in Cases 1 and 3 and both cases had a temporarily increased bleeding tendency. The young girl (Case 2) stood the treatment remarkably well without significant changes in the blood picture, and it should also be noted that menstruation remained normal after the massive I^{131} treatment.

In all three cases the tumours represented cytologically well-differentiated thyroid carcinomas predominantly of the alveolar type. In Case 1 the growth had its origin in an intrathoracic adenomatous goitre and produced metastases in the bones, lungs and subcutaneous soft tissue. In Case 2 the tumour was confined to the neck and this patient had large bilateral lymph node metastases with a history of at least three

years. This case is also interesting as an example of a thyroid carcinoma in a child (2). Case 3 was a classical example of the type of thyroid carcinoma which has been called 'benign metastasizing goitre'. She still lives in good health 19 years after the first thyroid operation and despite total thyroidectomy has had hyperthyroid symptoms from the functioning bone metastases. In Cases 1 and 2 the uptake of radioiodine varied markedly in different metastases. In Case 2 the uptake was probably more massive but in this case too, radioautographs revealed small parts of the tumour which did not store the isotope.

The possibilities of radioiodine in the study of the physiology of functioning thyroid carcinomas are illustrated in Cases 1 and 3. In the last case investigation of the plasma protein-bound I^{131} gave valuable information concerning the hormone-producing capacity of the tumours.

SUMMARY

Three cases of iodine-concentrating thyroid carcinomas treated with large doses of I^{131} are described. They represent well-differentiated thyroid adenocarcinomas predominantly of the alveolar type.

Relief of pain but no visible regression of the growths was obtained in two of the cases, but in the third, a marked therapeutic effect with the patient free from signs a year later was observed.

ZUSAMMENFASSUNG

Drei Fälle von Jod konzentrierenden Thyreoideakarzinomen, die mit grossen Dosen J^{131} behandelt worden sind, werden beschrieben. Sie sind gutdifferenzierte Thyreoideakarzinome von vorwiegend alveolärem Typus.

In zwei der Fälle erhielt man Schmerzlinderung, jedoch keine erkennbare Verminderung der Geschwulst; im dritten Falle dagegen wurde ein deutlicher therapeutischer Effekt beobachtet; der Patient war ein Jahr später völlig beschwerdenfrei.

RÉSUMÉ

Les auteurs présentent trois cas de cancer de la thyroïde fixant l'iode traités par de fortes doses d'I^{131}. Ce sont des adénocarcinomes thyroïdiens bien différenciés, surtout du type alvéolaire.

Dans deux cas ils ont obtenu un soulagement de la douleur mais pas de régression visible des tumeurs; mais dans le troisième cas il y a eu un effet thérapeutique important avec guérison apparente un an plus tard.

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BOOK REVIEWS

Radiotherapy in Cancer of the Breast with Particular Reference to the Value of Preoperative Irradiation as a Supplement to Radical Mastectomy. *Analysis of 1,418 New Cases.* By Sigvard Kaae. 189 pp. 12 diagrams and 73 tables. Acta radiol. Suppl. 98. Stockholm 1952. Sw. Kr. 20: —.

This volume presents an analysis of 1,418 new cases of breast cancer treated at the Radium Centre, Copenhagen, during the period 1931—1944. The study was carried out in an endeavour to elucidate the value of roentgen irradiation in the treatment of breast cancer, particularly of preoperative roentgen irradiation as a supplement to radical mastectomy in operable cases.

Chapter I gives a brief historical review of the treatment of breast cancer and Chapter II presents the writer's material.

Chapter III. In the entire series the five-year survival is 38 % of 1,401 and the ten-year survival 18 % of 633 cases of cancer of the female breast.

Chapter IV describes the treatment of operable cases with and without supplementary roentgen irradiation.

Chapter V. Operable cancer of the breast has been treated at the Radium Centre, Copenhagen, with radical mastectomy supplemented with preoperative and in some cases also with postoperative roentgen irradiation. The five-year symptom free survival among 463 patients was 51 %, in histologic stage I 67 %, and in histologic stage II 32 %. The ten-year symptom free survival among 141 patients was 32 %, in histologic stage I 45 %, and in histologic stage II 19 %. The first 109 cases received a moderate preoperative and a rather small postoperative dose of roentgen rays, while the remaining cases had a considerably heavier preoperative, but usually no postoperative dose. Comparing the two groups, the writer finds no definite improvement after the introduction of heavy preoperative roentgen radiation.

Chapter VI deals with the signs of marked local and regional progression. In these instances some advantage appears to be obtainable by supplementing radical mastectomy with heavy preoperative roentgen irradiation. In the majority of cases of this category, however, radical mastectomy does not appear indicated, as it frequently aggravates the prognosis.

Chapter VII deals with the radiosensitivity of breast cancers. On the whole, they are fairly radioresistant.

Chapter VIII analyses the incidence of local recurrence in the operative field and in the supraclavicular region on the operated side (the irradiated area).

Chapter IX. A total of 259 patients had had radical mastectomy in other hospitals before receiving moderate postoperative roentgen irradiation at the Radium Centre. In this group, the therapeutic results are considerably inferior to those in the group having preoperative roentgen rays followed by radical mastectomy at the Radium Centre. This is not due to a difference in the supplementary roentgen irradiation, but mainly to a difference in the performance of radical mastectomy.

Chapter X reports the postoperative and postirradiational complications. The latter were moderate following the heavy preoperative doses used in this series, but quite severe when, in a later series, essentially heavier doses were employed.

In Chapter XI the writer compares the therapeutic results in 129 cases, only 18 % of which had biopsy at the commencement of preoperative roentgen irradiation, with those in the subsequent 334 cases in which biopsy was a routine procedure (in 97.6 %).

No prognostic aggravation appears to have followed upon the introduction of systematic biopsy at the commencement of treatment.

Chapter XII discusses radiotherapy alone, and combined with limited surgery. Special interest attaches to the method used by McWHIRTER (simple mastectomy with heavy postoperative roentgen irradiation). It is yet too early to assess the value of this method in operable cancer of the breast.

Chapter XIII. Inoperable cases have an extremely poor prognosis. Of 346 cases, only 3 % survived for 5 years and of 190 cases, only 1 % survived for 10 years.

Chapters XIV and XV are devoted to carcinoma of the male breast and sarcoma of the breast.

At the present time, it is impossible to point out the treatment of choice in breast cancer. In operable cases we may select ordinary radical mastectomy with or without supplementary radiotherapy, extended radical mastectomy involving removal of lymph nodes in the supraclavicular region and along the internal mammary chain on the affected side, or of limited surgery such as simple mastectomy supplemented with heavy postoperative roentgen irradiation. The justification for preoperative roentgen irradiation as a routine supplement to radical mastectomy is in doubt. It is an advantage only in cases of marked local and regional progression, but most cases of this nature are inoperable and radical mastectomy does not appear to be indicated.

Autoreview.

BROCHER, J. E. W., Die Wirbelverschiebung in der Lendengegend. Georg Thieme. Leipzig 1951. D. M. 16,50.

The author gives a survey of our present knowledge regarding the various forms of displacement between two neighbouring vertebrae, the so-called 'displacements of vertebrae'. The displacement may be forwards, lateralwards or backwards. The clinical signs and radiologic diagnosis are described. The author gives a thorough description of true spondylolisthesis, the pathogenesis of which is very vague. Research into the relevant literature has been wide. The illustrations are numerous and good.

This work is in the nature of a reference book and is to be regarded as a complete monograph on the subject. As the extensive literature upon displacements of vertebrae and degeneration of discs is divided up into orthopaedic and radiologic publications, it is of value that the information concerning these problems has been collected into one volume and at the same time has received comprehensive elucidation.

Folke Knutsson.

STODTMEISTER, RUDOLF, SANDKÜHLER, STEFAN, LAUR, ALBERT: Osteosklerose und Knochenmarkfibrose, Georg Thieme Verlag, Stuttgart 1953, DM 28,50.

This work from the University of Heidelberg forms an extremely thorough description of the pathologic anatomy and clinical manifestations of these conditions. The survey of the literature is exhaustive.

It is important that the radiologist should be acquainted with these various systemic diseases and their relation to certain forms of anaemia. In this respect it is in osteomyelosclerosis that roentgen diagnosis is of special interest. The authors submit four cases of their own. The sclerosing involves the substantia spongiosa and in the beginning appears as a thickening of the different lamellae. Small sclerotic areas gradually develop so that the structure assumes a coarsely spotted appearance. At a still later stage, the whole substantia is transformed into a compact mass of bone (eburnisation).

The condition does not affect the growing skeleton but appears usually between the ages of 30 and 60.

The authors also describe two of their own cases of marble-bones and one rare case of periosteal hyperostosis.

In fibrosis of the bone-marrow, the authors, from experiences based upon 14 of their own cases, found no characteristic radiologic changes.

Folke Knutsson.

PHYSICS AND MEDICINE OF THE UPPER ATMOSPHERE. A STUDY OF THE AEROPAUSE. The Proceedings of a Symposium on the Physics and Medicine of the Upper Atmosphere held at San Antonio, Texas, November 6, 7, 8, 9, 1951. Editors C. S. White and O. O. Benson, Jr. The University of New Mexico Press, Albuquerque 1952. XXIV + 584 pp. $ 10.—.

This book contains a bewildering amount of information on the various aspects and problems of flight in the upper layers of the atmosphere — the aeropause, to use a newly-coined term — and in empty space. Almost anybody interested in geophysics, radiophysics, biology, medicine, and aeronautical engineering will find something of interest to him, but probably nobody will be able to read the whole book with full understanding, especially as many of the papers give only short sketches of very special subjects. Due to the large number of contributors, the same or closely related subjects are often treated in different papers a few hundred pages apart.

Topics of special interest to the readers of this Journal are, cosmic radiation and solar roentgen rays, their somatic and genetic effects on laboratory animals and on man, and the potential hazards they constitute in high-altitude flights. These problems are treated in very interesting and informative papers by J. A. VAN ALLEN, A. T. KREBS, H. J. SCHAEFER, H. J. MULLER, T. C. EVANS, J. M. TALBOT, and others. Though the hazards mentioned cannot yet be accurately assessed, the general impression is that they are slight as compared to all other hazards connected with such flights. The radiation from a nuclear reactor used as a source of power is, on the contrary, of such an intensity as to make proper shielding a very difficult engineering problem, on account of the weight limitation necessary.

Sven Benner.

DIZIONARIO TECNICO DI RADIOLOGIA. Italiano-Français-Deutsch-English-Español. Par Franco Fossati. Pubblicazione A. Wasserman, Milano.

The author mentions in the introduction that the dictionary has been produced in order to facilitate the comprehension of scientific articles in the radiologic sphere by technicians and students of various nationalities. In this, we firmly believe that the author has been extremely successful.

The editing as well as the arrangement of the words has been well thought out so that the whole is very easy to use. As far as we are able to judge, no objection can be raised to the words chosen or to their translation. It might perhaps have been desirable to have had synonyms for certain words which were to be translated to other languages.

As regards atomic physics, terms and meanings in this fairly new field are well represented in the dictionary and it is very satisfactory to find that most words have been included. The same opinion holds for radium therapy and chemistry.

It would have been valuable if, in order to make things clear, a few simple drawings, for example, of a roentgen plant for medical or industrial investigations with the various main parts in Italian, had been included in the book.

S. Mattsson.